ILLUMINATING ENGINEER

XVI | Dec. 1933 | Price 9d.

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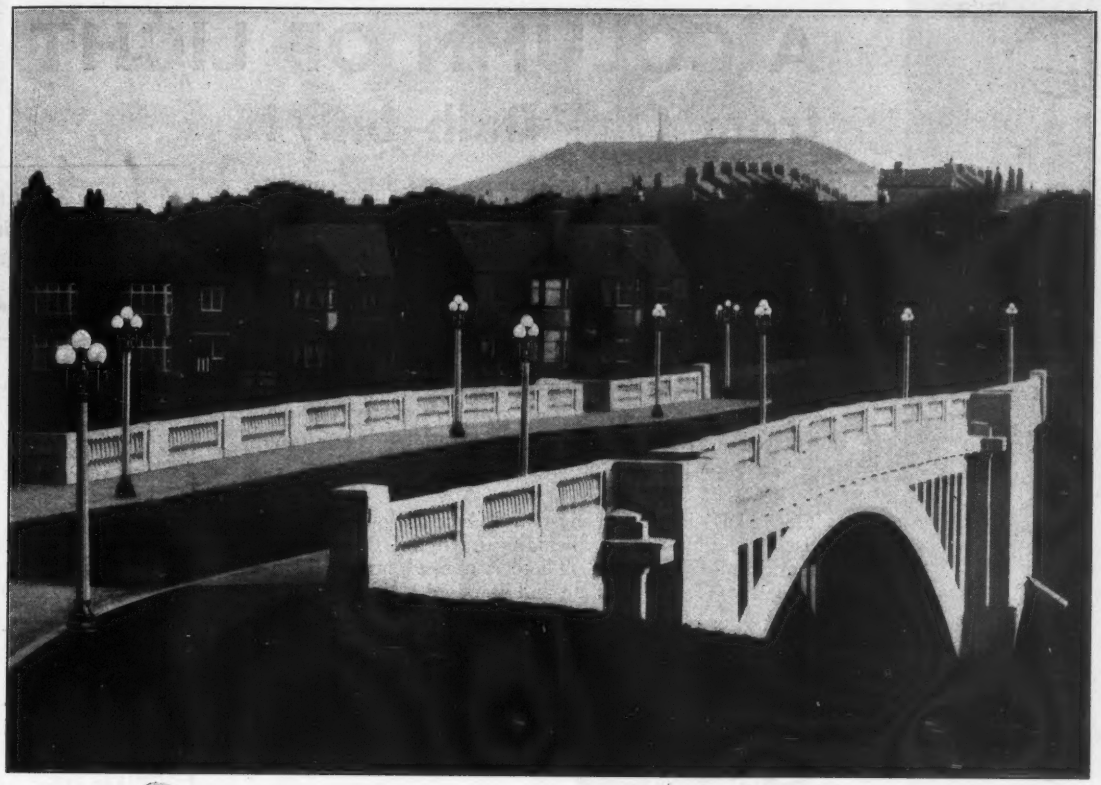

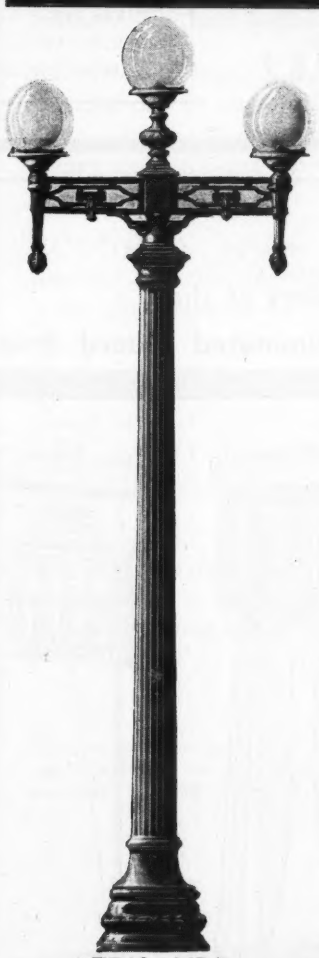

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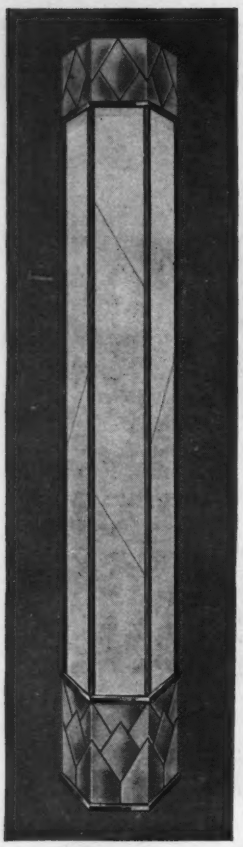

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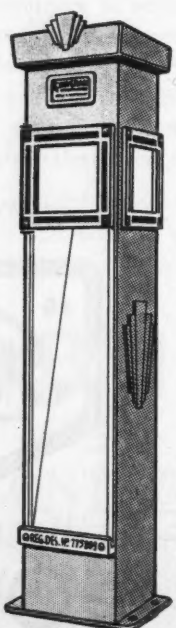

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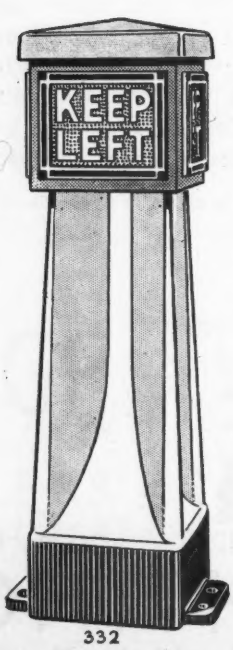
MINORETTE



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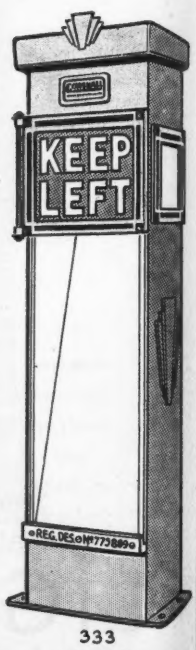

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THE ILLUMINATING ENGINEER

THE JOURNAL OF GOOD LIGHTING

LIGHT LAMPS FITTINGS AND ILLUMINATION

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OFFICIAL JOURNAL of
The Illuminating Engineering Society
(Founded in London, 1909, Incorporated 1930)
and of
THE ASSOCIATION OF PUBLIC LIGHTING ENGINEERS
(Founded 1928; Incorporated 1928)

Vol. XXVI December, 1933 Price NINEPENCE
Subscription 10/6 per annum, post free.

Edited by
J. STEWART DOW

EDITORIAL AND PUBLISHING OFFICES:
32 VICTORIA STREET, LONDON, S.W.1.
Tel. No.: Victoria 5215

The Lighting of Arterial Roads

THE paper on the above subject, read by Mr. A. M. Bell at the Public Works, Roads and Transport Congress on November 14th, was a somewhat unusual contribution on street lighting in that the author did not attempt to generalize, but confined himself to tracing the development of lighting on one particular route—the great Cambridge Arterial Road, which has only been in existence for about 10 years. During this short period, however, there have been changes. The traffic was originally light, and there was originally no necessity for point policemen. The presence of officers and special lamps at dangerous crossings soon became needful, however, and the traffic has since grown to such dimensions that nearly 5,000 vehicles may pass within 16 hours. Traffic-operated signals are already being installed at certain places.

It was not until 1927 that any public-lighting scheme matured. The road passes through five different Council areas. (Incidentally the Council with the lowest rateable value has the longest section of road to light.) In dealing with such roadways, therefore, the ideal can rarely be attained under present conditions. One may sometimes have to be content with unilateral lighting only, though this is admittedly inferior to illumination from both sides of the road. The great difficulty, however, is that the lighting committees of many parishes are reluctant to assume what they do not regard as a local obligation, and which in fact may well be beyond their financial resources. The streets of a town or city are planned and lighted for the benefit of its own citizens; on them, therefore, falls the obligation of meeting the bill, which the rateable value of the town property enables them to do. Long stretches of arterial roadway are of small benefit to the country parishes through which it runs, but serve the needs of travellers from distant towns and cities. Moreover, such sections of road commonly pass through areas where there are few houses and little rateable value. Small wonder that the burden appears excessive!

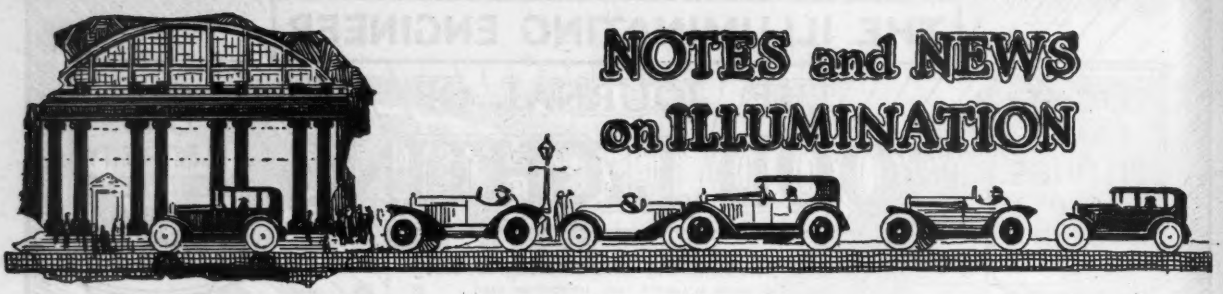
In the United States the same problem exists, but in a more acute form. There are said, indeed, to be only six states that have the power to impose rates to cover expenditure on rural highway lighting. In both countries the ultimate aim must surely be the same—to treat the problem on a national basis; funds for adequate lighting being collected and furnished by the central authority and regarded as a charge on the nation.

Aviation Lighting

AVIATION lighting, the development of which was traced very ably by Major Mealing in his paper before the Illuminating Engineering Society, on November 14th—immediately after Mr. Bell's paper on the same date—is, like the lighting of arterial roads, a new subject. Before the war, night flying was not attempted. Only in 1919—14 years ago—was the first aerodrome beacon for civil aviation erected. The problems involved, more complex than those involved in public lighting, are only now being dealt with on an international basis. It says much for the forbearance and patience of experts in this field that so much has already been accomplished.

On many points of detail fundamental differences in opinion on the part of pilots seem still to exist. The general outlook is likewise coloured by national experiences. It is, for example, not unnatural that our own pilots, who visualize flying as between continents, under conditions such that blazing the route is scarcely practicable, seem to attach less importance to ground-lighting than do experts in the United States who have such a large home area, fully under control, to cover. Nevertheless, we have little doubt that in this country, as flying becomes more general, artificial light will be used to an ever-increasing extent. Here, as in the case of public lighting, the great obstacle to progress is a familiar one—the expense.

We notice a suggestion, made in the course of the discussion, that leading towns might be induced, as a matter of civic pride, to erect local beacons, or facilitate the lighting of landing grounds. When night flying becomes really popular it will doubtless be to the interest of enterprising cities to take a lead in this respect. But this time has not yet come. It was also suggested that expenditure might be defrayed out of resources analogous to the Road Fund. This idea seems more fruitful—even if the number of private persons who might fairly be invited to contribute to such a fund is not yet great. (Major Mealing, we notice, seemed to view with some foreboding the spread of amateur flying by night). No doubt some contributors to a central fund could be found. But we think that, in this case, as in the case of arterial-road lighting, the problem is not a parochial but essentially a national one. Ultimately the lighting of the highways of the earth must surely be regarded as essentially an international affair; each nation defraying the cost of adequate lighting within its own boundaries and contributing to the illumination of connecting links.



The Illuminating Engineering Society

FORTHCOMING MEETINGS.

The NEXT MEETING of the Illuminating Engineering Society will take place in the Lecture Theatre of the E.L.M.A. Lighting Service Bureau (2, Savoy Hill, London, W.C.2), at 6-30 p.m. on TUESDAY, DECEMBER 12th, when a paper will be read by Mr. A. W. Beuttell, entitled "An Analytical Basis for a Lighting Code"; a method of computing values of illumination for various classes of work. This paper should lead to a most interesting discussion.

At the subsequent meeting, on January 9th, a paper is to be read by Mr. A. Cunnington, dealing with "Portable Lamps and their Applications."

The Annual Dinner has been arranged to take place on February 13th, which is the exact anniversary of the foundation of the Society.

Institution of Engineers-in-Charge

We notice that the programme of the Institution of Engineers-in-Charge also contains several items of interest to illuminating engineers. On February 14th there is a paper by Mr. R. C. Walker on "Photo-cells and their Application," whilst on February 28th Mr. W. J. Jones is to lecture on "Modern Methods of Electric Lighting," the meeting on that occasion being held at 2, Savoy Street. Another member of the Illuminating Engineering Society, Mr Stephen Lacey, is taking the chair at the earlier paper, on December 13th, by Mr. S. Adams, who deals with gas and coke-fired boilers for central heating and domestic water heating.

Non-reflecting Shop Windows

The problem of avoiding troublesome reflections of the sky and other bright external objects in shop-windows has often been discussed. Some illuminating engineers have recommended exceptionally brilliant artificial lighting of the contents of the window, such that images of external objects are of inconspicuous brightness in comparison. Whilst legitimate on dull days or in twilight, however, the use of artificial lighting to overcome the difficulty would seem too extravagant in bright daylight. Efforts have been made to avoid the trouble by special shaping of the window glass. A successful example of this method is now to be seen at the showrooms of the Westminster Electrical Supply Corporation, in Victoria Street. The window is deeply concave, the lower edge of the curved glass terminating some feet back from the facade-level. The intervening area, which is reflected in the window is painted a dead black. By reason of the curvature of the glass objects in the street are not reflected. The result is most striking, giving the impression of complete absence of glass between the eye and the showroom. The unusual design invariably arouses the curiosity of passers-by and serves as an excellent advertisement.

Light and Safety on the Highway

In *National Safety News* Dr. M. Luckiesh alludes to researches in New Jersey and elsewhere leading to the conclusion that the hazard by car is four times as great by night as by day. The question is often raised whether, on heavily travelled "highways" (which may be compared to arterial roads in this country) public lighting in the ordinary sense is worth while. Mediocre highway lighting, it is admitted, is of doubtful value On relatively well-lighted routes, however, the expenditure has proved well worth while. Diagrams were presented for the Bay Shore Boulevard (San Francisco) and the Schenectady County Highways (New York), showing a decrease of approximately 40 per cent. in night accidents following the installation of highway lighting—a result in fair accord with those for urban streets where it is believed that adequate lighting reduces night-traffic accidents by 35 to 50 per cent. It is, however, to be remembered that as yet there are only half a dozen States in which it is legally possible for any political unit (state, county or township) to pay for highway lighting. Conditions governing the design of motor-car headlights are therefore of great importance. In this connection the author emphasizes the necessity for adequate beam-power. An analysis carried out in Connecticut during 1932 revealed that only five accidents were due to glare, as compared with 32 ascribed to insufficient light. This result may appear in conflict with the views held by many people. Consideration shows, however, that in the case of cars travelling at 50 miles per hour headlamps must reveal objects at least 500 ft. away—the minimum braking distance. In the United States the necessity for two distinct beams, one for use on the open road, the other for use when passing other vehicles, is fully recognized. Recently, indeed, a further refinement has been introduced which permits the light on the left side to be depressed, whilst that on the right side is maintained or even augmented.

Illuminating Engineering in Australia

During the period October, 1934, to March, 1935, the City of Melbourne will be celebrating its first centenary. Illumination will play an important part in the programme, illustrating one hundred years of progress. We are asked by the Illuminating Engineering Society of Australia to state that any members of the British Illuminating Engineering Society who may be visiting Melbourne during this period will be most heartily welcomed. They should, however, inform the Secretary (at Law Courts Chambers, 191-195, Queen Street, Melbourne) of their respective dates of arrival, so that accommodation may be arranged or any other desired assistance rendered We are glad to learn that there is a general feeling in Australia that the cloud of industrial depression is lifting. We also hear that the Society has been advising the authorities on such matters as the drawbacks of inferior foreign lamps and the regulation of the brightness of powerful headlamps used by fast motorcraft in and about Sydney Harbour.

TECHNICAL SECTION

COMPRISING

Transactions of The Illuminating Engineering Society and Special Articles

The Illuminating Engineering Society is not, as a body, responsible for the opinions expressed by individual authors or speakers.

The Development of Aviation Lighting

(Proceedings at the Meeting of the Illuminating Engineering Society, held in the Lecture Theatre of the Institution of Mechanical Engineers, at 6-30 p.m. on Tuesday, November 14th, 1933.)

A MEETING of the Illuminating Engineering Society took place in the Lecture Theatre of the Institution of Mechanical Engineers, on Tuesday, November 14th. Members assembled for light refreshments at 6-30 p.m., and the chair was taken by the PRESIDENT (Mr. C. W. SULLY) at 7 p.m.

The minutes of the last meeing having been taken as read, the HON. SECRETARY read out the names of applicants for membership, which were as follows:

Corporate Members :—

Arnold, H. B. .....Sales Manager, The British Electric Lamps Ltd., Spencer Hill Road, Wimbledon, London, S.W.19.

Harris, S. E. .....Illuminating Engineer, 23, Hillcross Avenue, Morden, Surrey.

Krestin, D. .....Consulting Engineer, 14, Victoria Street, London, S.W.1.

Strange, C. .....Illuminating Engineering Draughtsman, 18, Westmead, Ewell, Surrey.

Willans, Miss E. .....Principal, Women's Advisory Staff, The Gas Light and Coke Co., 30, Church Street, Kensington, London, W.8.

Country Member :—

Denholm, N. H. .....Electrical Engineer, "Eildon," Moorside North, Fenham, Newcastle-upon-Tyne.

The names of those announced at the last meeting of the Society were read again, and these gentlemen were formally declared members of the Society.

The PRESIDENT then called upon Major R. H. S. MEALING to present his paper, entitled "The Development of Aviation Lighting." The paper traced the development of aviation lighting from the days prior to the war, when there was no flying by night, up to the present day. During the war aerial lighthouses were developed, but it was not until December, 1929, that the first aerodrome beacon for civil aviation was erected. In the subsequent section of the paper modern methods of (*a*) airway lighting and (*b*) aerodrome lighting were discussed and illustrated by numerous lantern slides, and, in conclusion, reference was made to the work of the British Aviation Committee. In the subsequent discussion Mr. P. GOOD, Mr. C. C. PATERSON, Mr. G. H. WILSON, Lt.-Col. C. H. SILVESTER EVANS, Dr. W. S. STILES, Mr. W. A. VILLIERS, Dr. W. M. HAMPTON, Mr. E. STROUD, Mr. A. CUNNINGTON and Mr. N. NORMAN took part.

After Major R. H. S. MEALING had replied to various points raised in the discussion, the PRESIDENT proposed a very cordial vote of thanks to him for his paper, which was carried with acclamation.

In conclusion, it was announced that the number of applications received to take part in the visit to Battersea Power Station had already exceeded the limit (30). It would therefore be necessary to decide the constitution of the party by lot. It was hoped, however, that a second visit, in which unsuccessful applicants would have an opportunity to participate, might be arranged later on.

It was also announced that the next General Meeting would take place at the E.L.M.A. Lighting Service Bureau, on Tuesday, December 12th, when a paper explaining a method of determining the values of illumination necessary for various purposes would be read by Mr. A. W. Beuttell.

Special Course of Lectures on Illumination

In our last issue an announcement appeared of the special course in illumination which is being given in connection with the Electrical Engineering Department of the Imperial College of Science and Technology. The course is under the direction of Professor C. L. Fortesque, aided by the staff of the department, and by Mr. Clough Williams-Ellis, F.R.I.B.A., Dr. R. Y. Lythgoe and Mr. G. H. Wilson, who act as special lecturers. The course is to consist of three lectures per week, on Mondays, Wednesdays and Fridays, at 5 p.m., starting on January 17 and ending on February 16th, 1934. There will be tutorial classes on Wednesday afternoons, and the remainder of the time will be devoted to laboratory work.

Such fundamental questions as the nature of light, the properties of artificial illuminants and materials used therewith, and photometry will be covered by members of the staff, whilst Mr. Williams-Ellis will deal with æsthetic requirements; Dr. Lythgoe with the human eye and its behaviour with different conditions of illumination; and Mr. Wilson with the designing of fittings for use with artificial illuminants.

Applications for admission should be made to the Assistant Registrar, The City and Guilds (Engineering) College, Exhibition Road, London, S.W.7.

The Development of Aviation Lighting

By MAJOR R. H. S. MEALING

(Paper read at the Meeting of the Illuminating Engineering Society, held at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1, at 6-30 p.m., on Tuesday, November 14th, 1933.)

WHEN I was first asked to present a paper on the subject of Aviation Lighting it was suggested that its title might be "Recent Developments in Aviation Lighting."

So much has happened in the last few years in the development of aviation lighting, and so little has been heard of its history, added to which it must be remembered that I am not a technician but merely a guide of technical policy, that not only did I feel more qualified but also that I could make it more interesting by generally outlining its past history and future development, therefore changed the title to a more general one—the Development of Aviation Lighting.

Prior to 1914 there was no night flying proper, as we know it to-day, and therefore, so far as I am aware, there was no night lighting. I must except, of course, the night flying exhibitions which were given at Hendon in this country and at a few places abroad.

To enable those exhibitions to be given the aircraft was outlined with small electric lamps, and the illumination to enable it to land was afforded by burning petrol in a bucket.

Then the Great War came, and with it the necessity for night flying proper.

Various devices were used for assisting aircraft to land, but the principle was always the same—namely, a line of flares—petrol or electric, in such formation as enabled a pilot to know—

(*a*) The position of the landing area proper, and

(*b*) To enable him to judge his height above the ground.

The most important development was the introduction of the aerial lighthouse. These were used in France to enable night flying squadrons to find their way home after bombing raids. They were, of course, an excellent aid to the night flyers, but they were also an aid to our then enemy aircraft for the reason that, as I know to my cost, when commanding a day scout squadron which was using the same aerodrome as a night squadron, we were flying most of the day and being bombed most of the night.

As in so many cases, good came from evil, and to-day civil routes throughout the world are provided with airway beacons which have gone far to make night flying safe.

I give just this very cursory picture of night lighting prior to and during the war, and now we arrive at the birth of civil aviation as we know it to-day.

Civil aviation in this country began its life at Hounslow Aerodrome (now returned to its former use as a cavalry training ground). There was erected the first aerodrome beacon, which was first operated on December 29th, 1919. This light was supplied by the Gas Accumulator Company Ltd., who thereby had an early if not the earliest connection with night lighting in this country, and I would like to take this opportunity of thanking Mr. A. G. Watson, of that firm, for the very valuable notes which he has supplied to me for this paper.

Prior to this date all beacons had been of the searchlight type, and one can readily appreciate the fact that a pilot is either in or out of the beam—mostly the latter—and from that date was it known in this country that the searchlight type of beacon was no use.

In spite of that it is worth noting that other countries for years afterwards continued to use the searchlight beacon until they realized that the very time it was wanted (i.e., at close ranges in bad weather) it could not be seen.

I suppose we were, as ever, better at scientific design than publicity, and it is certainly due to that error that the very false dictum (namely, "Airway beacons are no good, because when you can see them you don't want them, and when you want them can't see them") arose.

Those of us who are trying to forge ahead with night lighting are still having that fallacy thrown up at us.

I would like to take this opportunity of most emphatically saying that whereas airway lighting by itself is by no means valueless; as an aid to air navigation it is invaluable.

And that is the way airway lighting must always be considered—as an aid to air navigation.

I will refer later to the light-distribution of beacons, and will continue with the historical review.

In April, 1920, Hounslow was given up as the civil aerodrome for continental traffic, and Croydon took its place, but not of course the Croydon airport as we know it to-day.

New beacons, obstruction and boundary lights, an illuminated wind indicator, and even a landing floodlight, were within a very short time provided there.

Airway beacons were also provided on the Croydon continental route, and although very material changes have since been made to the actual apparatus, I think that acknowledgment should be made of the credit due to those who first devised the principles of this system of lighting, because, with certain slight alterations it holds good to-day throughout the world.

From 1922 progress was slight, and, although as I have said credit should be given to those in this country who devised the present-day principles of night lighting, it certainly required the enormous growth of night flying in America from 1928 onwards to provide the impetus which has to-day enabled us to make night landings at aerodromes and navigation on airways as safe as it is; and what is above all so very necessary to provide the stage at which international agreement has arrived.

This question of international agreement is an extremely important one when you realize that the night-mail machine of the future will pass right through some countries in two to three hours.

We must ensure that we in no way hinder development of the apparatus used, but even to-day we know enough to standardize principles, and it is by that standardization that we can simplify night lighting, and directly by its simplification can we make night flying safer.

The first step in obtaining this international agreement was taken by the International Illumination Commission at its meeting at Saranac (U.S.A.) in 1928.

Other than the fact that up to that time there had been a small amount of international agreement on the subject of lighting by virtue of the agreement contained in the International Air Navigation Convention, I will not go so far as to say that that agreement was honoured more in the breach than

FIG. 1. -Tatsfield Lighthouse.

FIG. 2.—Location Beacon (Penshurst and Littlestone).

FIG. 4.—Wind Indicator.

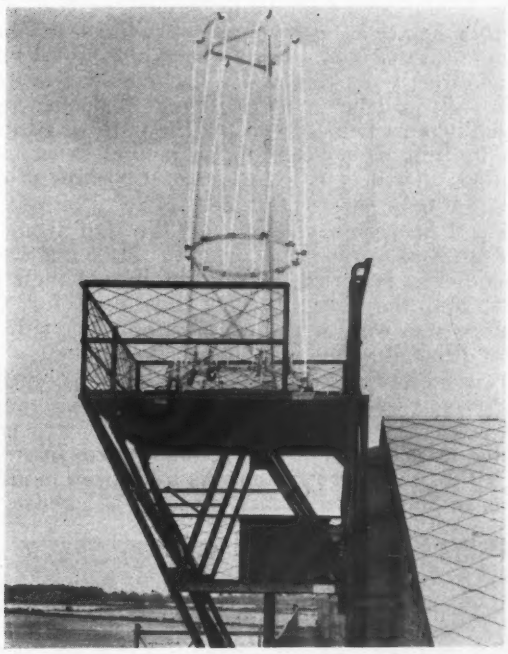


FIG. 3.—3-kw. Neon Aerodrome Beacon.

in the observance, but it certainly has not been strictly adhered to.

Be that as it may, the agreement that was reached some twelve or so years ago formed a very useful foundation for international agreement, and it is only within the last year or two that we have been able to formulate any suggestions for amending it.

The manner in which the question of obtaining further international agreement was approached was to decide the minimum amount of lighting required, to define and state the fundamental requirements of each necessary light, and perhaps later to prepare a specification for the lighting as a whole.

I can perhaps indicate the suggestions for international agreement and the work of the British Aviation Lighting Committee at the same time.

It is necessary to divide aviation lighting into two subjects, viz.:—

(*a*) Airway lighting.
(*b*) Aerodrome lighting.

I will deal with these two subjects in the order in which I have given them, because it is in that way easier to indicate how an aeroplane is guided along its route to its destination and then assisted to land.

Airway lighting can of itself be divided into two parts, which might be referred to as the aids and hindrances to air navigation. By "aids" I mean the beacons which show the way, and by "hindrances" the obstructions which get in their way.

It might be of interest if I say a few words regarding a certain departmental Air Ministry Committee, known as the Preliminary Committee for the Control of Air Navigation.

The terms of reference for this committee, which is composed of representatives of the Service, civil

and technical branches of the Air Ministry, include the making of recommendations relating to all aids and hindrances to air navigation—it being remembered that where safety is concerned there is no difference between Service and civil flying.

It may be found necessary later to set up a committee representative of all responsible Government departments, such as the Air Ministry, Board of Trade, Admiralty, Trinity House, etc., which would be the governing body relating to air navigation, and particularly with regard to lights.

The two most important requirements for an airway beacon are its design and its location.

For use in a country which is liable to suffer from bad visibility, and yet which is not too bad for flying, it will be readily appreciated that it is most important that the design of the beacon must be such that its angle of light-distribution in a vertical plane should be continuous from the horizontal to the zenith. The horizontal part of the beam of great intensity enables the beacon to be seen in good visibility at a great range and the vertical part of the beam which, although its intensity is not and cannot be so intense as the horizontal beam, enables the beacon to be picked up in conditions of bad visibility at short ranges if not when actually over it.

I can illustrate the necessity of having plenty of light in the upper limits by saying that in clear weather I have been not more than 1,000 ft. above Dungeness marine lighthouse, and although I knew I was directly above it was quite unable to see any light. It will be understood that if such a light (which it must be accepted for the purpose of aviation lighting is a searchlight) is useless in clear weather, it will equally be understood how utterly useless it is in bad weather.

It will be within your knowledge that from the year 1928 a very large amount of money was expended in America on the lighting of their airways, and the beacon which was used for that purpose was one of the searchlight type with the beam directed slightly above the horizontal.

It was soon discovered that whereas such a beacon was excellent when viewed at long ranges and in clear weather at short ranges it was practically invisible, and I understand that many, if not all, of their airway beacons have been modified so as to show a secondary beam at 55° above the horizontal.

Without desiring to be egotistical about the latest British type of airway beacon merely because it is British, I feel sure, for the reason that its light-distribution is continuous from the horizontal to the zenith, that the design is correct. I must, however, emphasize the fact that the design is applicable mostly to this country where a large percentage of bad visibility prevails.

For overseas use, and particularly for Empire routes, one can almost entirely rely on long-range beacons where the light-distribution is concentrated to a high intensity in a small vertical angle just above the horizontal. The reason for that design is that visibility overseas, whilst not quite without exception, is mostly so good that it is not necessary to deflect any of the light into the upper angles in order to use it as a short-range bad-weather beacon; and when the visibility is bad it is so bad that it is practically impossible to fly and the beacon is not required.

I might make a reference here to the latest type of track-indicating beacon, which is going to be of great assistance to pilots on Empire routes. The idea of the beacon is not only to perform its normal function as a beacon but also to indicate a desired track to and from that beacon.

The location of the beacon has to be considered in two planes—horizontal and vertical. It must as nearly as possible be on the exact line of the airway, and it must also be above the fog line and below the cloud line. In this country that usually means a height above sea-level of anything between 200 ft. and 500 ft.

Many attempts have been made to recommend a definite and fixed distance between one beacon and the next along an airway, but I am firmly of the conviction that not only is that the wrong method of spacing beacons but, having regard to the manner in which the topography of a country can vary in a short distance one can say that such a method is impossible.

One can, however, define a principle for spacing beacons which will suit all types of beacons and all kinds of topography. It is this. Beacons should be spaced in such a manner that, having regard to the local topography, a pilot who does not deviate more than 5° from the track between any two beacons will pass within visible range of the next beacon under the worst weather conditions in which regular night flying would normally be carried out in the locality. By following that principle one can employ small beacons closely spaced, such as might be necessary in hilly country, or one can use large beacons widely spaced in open country.

I have not referred to the character of an airway beacon.

It has been in the past our habit to use Morse characters, but there is more than one objection. In the first place, there are few Morse characters which can be used owing to the difficulty of having the character repeated in a reasonable time. Secondly, one cannot obtain a high enough intensity with a Morse character beacon; and, thirdly, from a navigational aspect, it is difficult, if not impossible, for a pilot to memorize a large number of characters which would be necessary owing to his passing a beacon somewhere about every ten to fifteen minutes. Therefore it has been decided to use what is known as a single-flash beacon. This type overcomes every one of the objections to the Morse character beacon.

To enable a pilot to know not only which route he is on, but precisely where he is on that route, each beacon will have a small short-range identification light on the top, which will have its own character, and will not be repeated within one hundred miles.

The colour of the main beacon will be white, and that of the identification light red.

It might be of interest if I quote here paragraph 19 of the Air Navigation (Consolidation) Order of 1923, which paragraph defines the necessity for obtaining approval prior to the erection of any beacon, and also before changing the character of any existing beacon. It reads as follows:—

> "An aerial lighthouse shall not be established or maintained within Great Britain and Northern Ireland, nor the character of the light exhibited therefrom altered except with the approval of the Secretary of State, etc."

A pilot will thus be led along his route by a chain of beacons whose main character will be a single white flash, visible at long range in good weather, but equally visible at short range in bad weather, and will, in addition, be able to identify each beacon (which will be marked on his map) as he travels along.

In that manner will he be "aided." One must now consider the manner in which he will or might be "hindered" by obstructions.

So far as the physical features of the country over which a pilot is flying are concerned, he can

normally acquire all the information he requires from his map. But there may be some artificial obstructions on or near enough to his route as to be a danger. By artificial obstructions I refer to wireless masts, very tall chimneys, overhead electric-cable towers, and anything else which comes under the same category.

Where such an obstruction constitutes a danger to air navigation it should be illuminated by night with fixed red lights, of which one will be at the top and the number and location of the others according to the height of the obstruction above the ground level.

To illustrate how many factors have to be taken into consideration when dealing with lighting, not very long ago some wireless masts were erected not far from the Manchester municipal airport, which masts are used in conjunction with the wireless station at that airport. These masts were also quite near the Manchester-Liverpool railway line. The Air Ministry specified the number and type of obstruction lights which had to be fitted to each mast, and they were duly fitted.

It was not very long before we had frantic messages from the London Midland and Scottish Railway Company saying we were stopping all the trains from Liverpool to Manchester. Little did one know that the red obstruction lights on the wireless masts were dead in line with one of the railway signal posts where the railway line makes a slight curve.

That was bad enough, but what the L.M.S. authorities were quite naturally really frightened of was that, sooner or later, a driver might think he was looking at the wireless mast, whereas he was looking at the signal light, and go past it with disastrous results.

That difficulty was got over by fixing very small shields in front of the obstruction lights on the masts. Those shields have proved sufficient to prevent the light being seen from the railway line, and yet hardly detract at all from the usefulness of the lights for the purpose for which they were provided.

I should like to make a brief reference to the danger caused by the new overhead electric-cable system commonly known as the "grid" in this country. There has in the past been much bother concerning them made by certain well-known people in aviation.

I don't agree with much that has been said in that respect.

They must first be considered in the light of whether they are or are not an obstruction. Most often, except in the vicinity of an aerodrome, they are no more dangerous than anything else. If, however, by virtue of their height and/or their location, they do constitute an obstruction, they are undoubtedly an exceedingly dangerous one.

We can now imagine that a pilot has been led along his airway by the beacons; he has avoided the dangerous obstructions because they are illuminated, and now he is approaching his aerodrome of destination.

It has been written that the aerodrome of the future will be built first, and that the city will be built around it. I am not going to say that, but it will certainly be necessary for some aerodromes to be located well within the confines of the city—there are some examples already.

But for the time being most aerodromes are located on the outskirts of the city.

A pilot has got to be told exactly where the aerodrome is, and although he will be led practically to it by wireless, he requires to have it indicated to him more precisely by an aerodrome beacon. When one considers the thousands of multi-coloured, sometimes flashing, advertisement signs which have been erected in the last few years one can realize the difficulty of designing a beacon which can under no circumstances be mistaken for one of those signs or for any other light.

That beacon has to be distinctive from every light in the district, and has moreover got to be different

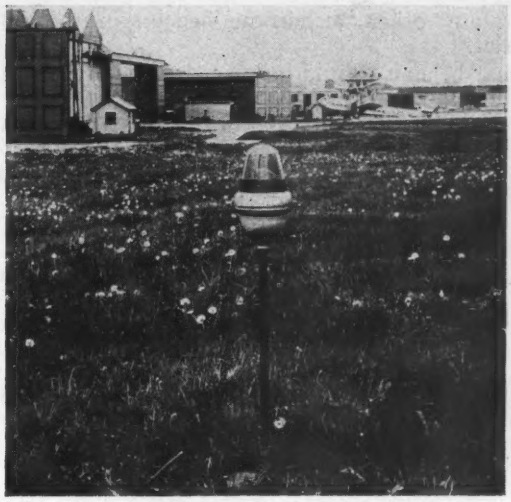


FIG. 5.—Electric Boundary Light.

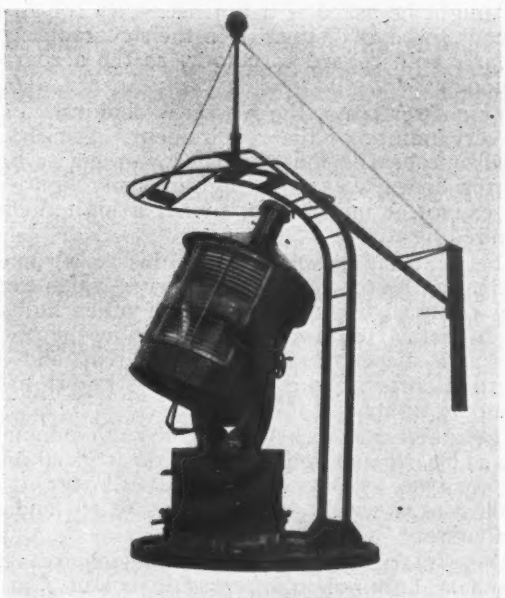


FIG. 6.—Shadow Bar (10-kw. Floodlight).

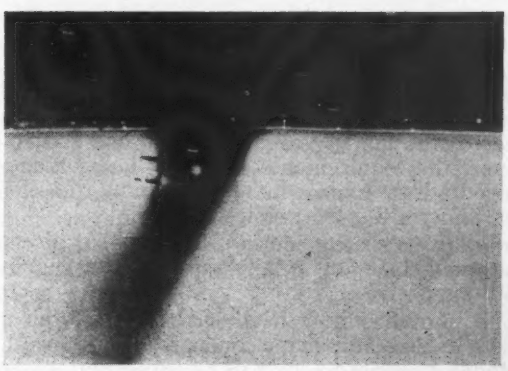


FIG. 7.—Effect of Shadow Bar.

from any other aerodrome beacon in the same district.

That beacon should be placed on or near to the aerodrome it is to indicate.

It is suggested that normally an aerodrome beacon should be red in colour and possess a code character which will consist of a single Morse letter. The same code character should not be allotted to any two aerodrome beacons within 100 miles of each other.

It is common knowledge that for some time many people were under the impression that the light emitted from a neon tube possessed some inherent property which enabled it to penetrate fog better than any other light. I am assured by those better qualified to speak than I am that such a supposition is incorrect.

Whereas the neon tube lends itself admirably for use as an aerodrome beacon, it possesses no better fog-penetrating power than a white light passed through a red filter emitting the same hue wavelength.

It might be asked is it not necessary for airway beacons to be as distinctive in their character, particularly with regard to colour, as the aerodrome beacon?

The answer is no, the reason is obvious. From the very nature of the requirements of each, the aerodrome beacon must emit a low-intensity light, and the airway beacon a high-intensity light, and one cannot, I understand, obtain a high-intensity coloured light.

The pilot has now been led to his aerodrome of destination by the aerodrome beacon, which can be very easily distinguished from all other lights in the district. He now requires to know the precise size and shape of the landing area, and this information he obtains from what is known as the boundary lights.

The function of these lights is to outline by night just as clearly as a fence, hedge, or artificial markings will do by day, the actual perimeter of the landing area within which it is safe to land and manœuvre.

The International Convention requires that boundary lights should be red in colour, but the various meetings of the International Illumination Commission have gone to show that there is from the technical aspect international agreement that normally they should be orange in colour and fixed in character.

It is also suggested, as the result of certain experiments which have been carried out, that they should be spaced at intervals of 300 ft. on the perimeter of the landing area. This figure was found to meet the requirements of a pilot being able at a glance to draw an imaginary line around the landing area, and yet was economically possible.

Any larger spacing did not meet the requirement mentioned, and any smaller spacing was unnecessarily expensive.

The pilot has now been led to his aerodrome, knows its size and shape, and prepares to land.

His first requirement is to ascertain the direction of the wind, for it must be remembered that an aeroplane must always land against the wind.

He obtains the direction and possibly the velocity of the wind by reference to an illuminated wind indicator.

This piece of apparatus takes the form of the letter "T," both arms of which should be approximately equal in length, and not less than 16 ft. in length.

The apparatus is so fitted with vanes along the main arm that it lies with the head at 90° to and against the wind. In other words, the direction of landing is as shown by the main arm in the direction of the head.

The "T," as it is called, should be outlined by white light, or any colour approximating thereto, to an intensity of 10 to 15 candles per foot run.

The pilot can now choose his exact line of approach for landing and begins to glide down.

Try as one will, one cannot avoid having many dangerous obstructions around and on an aerodrome. It is necessary to light every one, and that is done by outlining them vertically and horizontally by fixed red lights.

Such a form of lighting will enable the pilot to glide either over or past them.

All that is now left for the pilot to do is to land the machine, and for that purpose he requires a landing area floodlight.

He should normally land over the floodlight, and then down its beam.

Many devices have been produced to enable the pilot to land across or even against the beam, but I think it will be agreed that the ideal form is where the pilot lands over the light and away from it.

Thus the pilot ends his journey. By the aid of various forms of lighting he has been led along his route, and he has avoided any obstructions thereon. He has been brought to his aerodrome, and then safely led down to the ground.

I have not supplied any technical data regarding the actual lights because that will, in due course, be issued in the form of a British Standard Specification, which specification one can express the reasonable hope, in view of the measure of agreement which has already been attained, that it might become international at least in principle if not in actuality.

It would be more appropriate if I here took the opportunity of acknowledging the valuable work, almost completed, of the drafting sub-committee of the British Aviation Lighting Committee, which has compiled the British Standard Specification for Airway and Aerodrome Lighting, and which is about to be submitted to the Air Ministry for approval.

What I have actually done is to more or less describe the work of the British Aviation Lighting Committee during the last four years.

That Committee, when it commenced to function, decided that the only reasonable manner to tackle the subject was to formulate its own ideas on what were the absolutely necessary lights on an airway and at an aerodrome, and then to try and obtain international agreement with a view to suggesting later modifications to the existing international agreement.

The next line of approach was to state the fundamental requirements of each of the necessary lights.

The British Committee attended meetings at Berlin in 1930, Cambridge 1931, and Zurich in 1932, at all of which it was their aim to obtain as large a measure of international agreement as was possible on the principles of airway and aerodrome lighting.

Since 1931 this country has been the secretariat for aviation lighting, and I am very glad to say that the proposals which we submitted to the Zurich meeting were to a surprisingly large degree adopted.

Such advances are made from year to year in any new subject such as aviation that if only one can standardize principles one is at least obtaining some very necessary measure of standardization, and yet, what is more important, one is not retarding development.

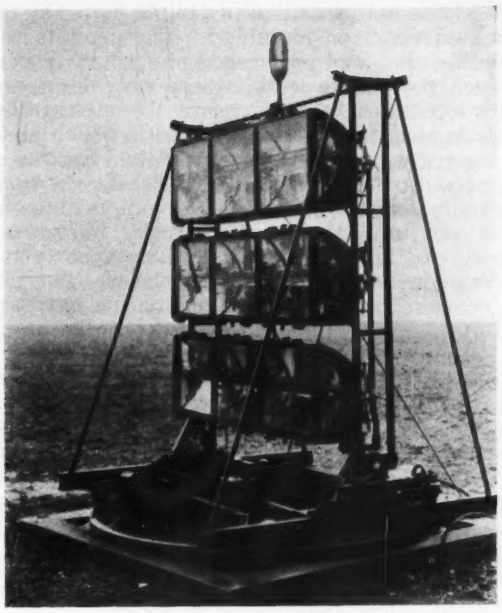


FIG. 8.—9-kw. Floodlight.

Night flying has not made the progress in this country that it has in Germany and America, but, anticipating that it might progress, and as usual without any real warning, the British Committee issued last year with the approval of the Air Ministry a "Guide to Aerodrome Lighting," which one might term an intelligent anticipation of what the final specification will be.

It was hoped that the "Guide" might be useful to all authorities responsible for the organization of aerodromes, and would give them some indication of what is really required.

The most prevalent mistake of the uninitiated is to suggest the provision of lights which, in conditions of good visibility might be sufficient in their intensity, but under conditions of bad visibility are useless, they are quite forgetful of the fact that it is under those conditions a visible light is most necessary.

One might make some reference both from a national and an international aspect, to the question as to who should provide the necessary lighting on airways and at aerodromes.

I cannot help but feel that if any country wants to attract air traffic, and in this case night air traffic, it must light its aerodromes and airways. There are instances, of course, where an air line might pass through a country and be of little use to that particular country, and in that case some special arrangement must be made.

From a national point of view it seems fair to suggest that the owners or licensees of the aerodrome should provide the necessary aerodrome lighting.

So far, in this country, airway lights have been provided by the Government, but I cannot say whether that practice will continue.

There is rather a tendency for operators of aircraft to look upon the providers of all lighting equipment as philanthropic institutions, but as in every other walk of life whatever is provided has got to pay for itself either directly or indirectly.

In other words, sooner or later one has got to consider the imposition of some form of light dues based on possibly present-day marine practice. Such a suggestion seems eminently sound to me, and I cannot think of a better one.

Whether it is necessary to create some body equivalent to Trinity House for that purpose I am not prepared to say, but it might be worth considering.

FIG. 9.—Floodlight (10-kw.), Lympne.

In this brief review I have endeavoured to tell you how aviation lighting commenced, the reasons for its use, the stage it has reached, and to make some suggestions for its operation and management in the future.

Any opinions expressed in this paper are to be taken as my personal opinions.

DISCUSSION

Mr. PERCY GOOD, in opening the discussion, remarked that Major Mealing's paper contained some provocative features, which should stimulate discussion. He (Mr. Good) was sure that Major Mealing would enjoy it if the challenges were accepted; Major Mealing had given an account of aviation lighting, written from the standpoint of one who had seen it since its inception. This story should prove a very valuable record for the archives of the Illuminating Engineering Society in the future.

Major Mealing had referred to International Meetings, and he (Mr. Good) would like to contribute some account of Major Mealing's connection with them. Following the meeting at Saranac, the International Illumination Commission had decided to deal with the lighting of aerodromes and airways, and the British Committee was asked to take a share in the work. General Sir Sefton Brancker, who was then Chief of the Civil Aviation Department at the Air Ministry took their usual broad view and agreed to participate in the work. Major Mealing was delegated to represent the Air Ministry, and was made Chairman of the National Sub-Committee dealing with this subject. Within a week of his being made chairman he had to act as host to a number of delegates from other countries, and he will recall how anxious they all were as to what it would be possible to accomplish.

These international meetings had continued, and Major Mealing had participated in all of them and a good deal of progress in international agreement had been made. The committee became a committee of the British Standards Institution and secured approval to the issue of a Guide to Aerodrome Lighting. A British Standard Specification had now been completed, and was under review by the Air Ministry, and when issued this should prove quite useful. He (Mr. Good) thought that Major Mealing had presented an extraordinarily interesting paper, and had contributed a very informative survey of what was being done.

Mr. C. C. PATERSON said that there were many others engaged on the work of design and testing out of appliances who could contribute more usefully to the discussion. He only wished to endorse what Mr. Good had said in regard to the steps towards standardization and agreement on aviation lighting, and to confirm the value of the work which had been done during the past five years. When one recalled that early meeting in London in 1929, the difficult meeting in Berlin in 1930, the International Illumination Congress in 1931 and the final successful meeting in Zurich in 1932, one realized what could be done in harmonizing divergent views by consistent and steady work. He would like to know to what extent the Zurich recommendations were actually being worked to by different countries. The main principles of aviation lighting had been outlined, but he had not heard whether the various Governments have approved of them. He, too, would like to pay tribute to the efforts of Major Mealing and his colleagues, who had been at the back of so much of what had been achieved in agreement regarding aviation lighting.

Mr. G. H. WILSON said that as a member of the British Committee which meets under the chairmanship of Major Mealing, he would like to say how much they appreciated the energy and enthusiasm which he put into his work on this Committee. It was very largely his enthusiasm and drive which had carried the work forward. After many battles and differences of opinion they had reached a successful conclusion, and now they looked forward to the issue of the Specification at an early date. His own view in regard to night flying was that aviation generally would not take its proper place as a means of transport until aircraft generally was able to carry on through the night as well as by day. This was possible with all other forms of transport, and they looked forward to its being so with aviation. He had heard it suggested that there was a vicious circle—flying people said there is not sufficient light provided—lighting people said there was not sufficient night flying to necessitate light. If this impasse continued it would greatly hinder the development of the lighting of air routes.

Major Mealing had raised the question of finance and the method of paying for lighting. As an alternative he suggested the formation of an Air Fund—something similar to the Road Fund—to be levied on all aircraft. This would distribute the cost. The scheme should apply to all aircraft, and not only to flying at night.

Mr. Wilson then asked a question regarding airway beacons and their maintenance. He said that one could imagine that the changing of one lamp automatically would only take a minute, but what happened if the second lamp failed? What supervision was being arranged to guard against this? With regard to boundary lights, the view of the International Illumination Congress was that they should be orange in colour. He believed, however, that neon lights were used abroad, and had proved very successful. Abroad one also observed long neon obstruction lights outlining church spires—a procedure which he found rather distasteful. Would it not be possible to install the lights so that they were visible to aircraft, but could not be seen from the ground? He would like to have Major Mealing's views on these points.

Colonel C. H. SILVESTER EVANS said that the author had given a review of the conditions as they are to-day. These conditions he presumed primarily met the demand of commercial aircraft, and he was led to enquire whether the lighting requirements indicated in the paper would be anything like adequate if the number of owner-pilots flying by night increased very considerably. These pilots would generally be making relatively short journeys between populated areas, where only long night-flying experience would ensure the aircraft being safely landed on an aerodrome within such an area having regard to the usual extraneous lighting of a large town. It would seem that drastic restrictions will ultimately have to be placed upon illuminated signs and other confusing lighting likely to endanger the safety of both aerial navigation and landing—just as restriction is placed on lights showing seaward likely to endanger marine navigation.

With regard to the failure of the searchlight type of beacon. This was not surprising, and one wondered if it was really efficient with a secondary beam at 55° deviation. It was stated that this type of beacon was practically invisible at short ranges; data as to the ranges and elevations at which it ceased to be usefully visible would be of interest.

There appeared to be one case where a high-intensity concentrated beacon might be of use, and that was where the contour of the ground did not permit location of the beacon above the fog line and below the cloud line.

Noting the divergence between the requirements of the International Convention for boundary lights (that they shall be *red* in colour) and the technical aspect of the same problem answered by the International Commission on Illumination (that they shall be *orange* in colour and fixed), it would be interesting to learn the views of the users—the pilots—and to hear what the solution was. Unfortunately, the technical aspect was frequently very far from the practical.

There was one aspect of aerial navigation not referred to in the paper, namely, devices for forced landings at night. It would be of value to know which was the better, the wing-tip flare or some auxiliary floodlight on the aircraft.

In conclusion, Col. Evans remarked that Major Mealing was to be congratulated on this concise review of the subject. He hoped that in the near future the Society would provide a further paper giving the scientific data which have determined the adoption of the equipment described.

Dr. W. S. STILES wished to mention one point of general interest. Aviation Lighting differed from most other applications of light in that it was a cut and dried issue, a clear case of functional lighting, no other elements entering into it. Someone had raised objection to neon tube lighting on church spires; this, he agreed, did introduce possible controversy on æsthetic grounds, but he did not think that if the safety of aviation were involved many people would object to the practice. In dealing with aviation lighting, one had to consider not only technological problems in producing various types of light but also the visual properties of the eye. Data in regard to the response of the eye to different kinds of light were of very great importance. He had recently had occasion to collect data of this kind and was surprised at the paucity of experimental measurements which could be applied to the needs of aviation. The use of orange for boundary lights was a case in point. The success of this practice depended on the power of the eye to distinguish between orange on the one hand and white and red on the other. The important question was: within what limits of wavelength must the dominant hue of the orange light lie in order to achieve the necessary distinctiveness? There was, he believed, only one investigation on this particular property of vision available and even this investigation, although a very valuable piece of

work, was not primarily directed to the problem of aviation boundary lights and did not cover all the points involved. Further studies of the response of the eye to different types of light under various conditions met with in practice were undoubtedly necessary. Nevertheless practical considerations made it desirable to have immediately some kind of specification of lighting requirements for aviation, and this the Aviation Lighting Committee had accomplished. He would only ask that the provisional character of the present specification should be borne in mind and that we should be prepared to modify it when information was obtained of the visual principles upon which it was based.

Mr. W. A. VILLIERS said he would like to ask Major Mealing if he thought it feasible for the Air Ministry to get out a complete scheme of aviation lighting embracing the chief towns in this country. He wondered if it would be possible to prepare a scheme assuming that leading town councils in the area were responsible for the cost in the same way as for street lighting, and to start the ball rolling by getting out a chart of the towns to be equipped with night landing apparatus and the minimum requirements. The Air Ministry might initially approach fifty towns and perhaps see whether they could get support from their town councils. Surely if a few towns agreed the others would follow suit —if only in order to make sure they were on the night flying map! Would Major Mealing say whether he thought this idea feasible and whether the Air Ministry were in a position to make a recommendation of this sort.

Dr. W. M. HAMPTON recalled that one of the previous speakers had suggested that the paper was provocative, and he himself felt that this was an unjustifiable accusation as the paper appeared to him to be definitely non-provocative, and he was sure that this was deliberate on the part of Major Mealing. He would, however, like to take up two technical points: In the paper, Major Mealing had suggested that one needed a considerable amount of light right up to the zenith under conditions of bad visibility and he had also suggested that no light was needed upwards under clear weather conditions, but the speaker felt sure that this was liable to misinterpretation and he was sure that it was not what the author intended. There must, under all weather conditions, be some light sent upwards, how much being entirely dependent on the weather conditions. It must be remembered that thick weather for flying was only slightly hazy according to the usual acceptance of the man on the ground. With reference to Major Mealing's comments on the shadow bar and the photograph taken at Heston, he would explain that this did not indicate that there was any difficulty in manipulating the shadow bar so as to avoid dazzling the pilot. The shadow bar and the aeroplane were of necessity both stationary while the photograph was being taken, as a comparatively long exposure was necessary. The shadow was deliberately arranged to fall half across the machine in order to make sure that the aeroplane would be seen in the photograph. He would like to emphasise that illuminating engineers owed a great deal to Major Mealing. Although according to his own estimate, with which the speaker did not necessarily agree, Major Mealing was not an illuminating engineer, he had had the foresight to call in experts to formulate the fundamental requirements for aviation lighting before the subject had developed very far. All illuminating engineers would appreciate that this was a matter of considerable importance, and they could all think of branches of illuminating engineering in which it was a pity that similar guidance had not been given in the early stages.

Mr. E. STROUD suggested that the luminous circle visible in one of the lantern slides might possibly be a flare effect due to the camera lens.

Mr. W. G. BROOKER stated that in regard to airway beacons the author had said that the light-distribution should be continuous from the horizontal to the zenith, and that the vertical part of the beam was not, and could not, be so intense as the horizontal beam. Was he to understand by this that it was undesirable for the beam to be of constant intensity from the horizontal to the vertical or zenith? He understood that the distribution was not symmetrical in the horizontal plane, and enquired whether a single beacon was used at the intersection of two air routes. The question of local councils helping to pay for the lighting on air routes was one affected by public opinion; local residents, for example, might object to the noise of night flying.

Mr. NIGEL NORMAN said he would like to add his thanks for the paper. Major Mealing spoke from actual experience, as he did much night flying. One of the most important things in night flying was to take the view of the pilot, and he noticed that in the discussion they had not yet had the opinion of those who have had actual flying experience. Night flying was more common in America, where more provision for it was made. He believed that night flying now exceeded day flying in the number of miles flown by commercial aircraft. Similar arrangements were needed in Europe. He would like to ask one or two questions. Should it be possible when situated near one beacon to see the next one? Could Major Mealing give us some idea of the maximum intensity necessary to effect this? In bad weather high-power beacons were necessary. Surely the beacon near a terminal aerodrome was the most important one. Was it really essential to have a low-power beacon in order not to dazzle pilots.

In regard to boundary lights, the Convention specified red and the International Illumination Commission said orange. He thought that the pilot would prefer flashing lights. In regard to the illuminated wind indicators, he might point out that the design should be such that the direction of the "T" could be judged from the ground. It was as important that pilots on the ground should be able to use it as well as those in the air. He would also like to refer to one other form of aerodrome lighting—"the eight-pointed star." For this purpose eight equally spaced lights round the perimeter were used. This form was adopted in many places abroad, and pilots seemed to like it. It seemed to him that the final form of aerodrome lighting was still indefinite. One thing there was no doubt about—price! He thought that the best way to break the "vicious circle" referred to in the discussion was to reduce the price of equipment. Recent developments had helped enormously. The problem was well worth the attention of the illuminating engineer.

Major MEALING, in reply, said that he must thank those present for the very kind things that had been said about his own efforts in connection with aviation lighting. Those results would never have been achieved without the hard work and the co-operation of the Committee, of which he had the honour to be the chairman. He would like to thank all those who had helped, speaking not only for himself but also for the Air Ministry. It was surely an important step to have prepared a Specification for Aviation Lighting. Mr. Paterson had asked what

measures of acceptance had been secured for the resolutions passed at Zurich. He was glad to say that a good many of these resolutions had been confirmed, but there were still some outstanding points, all of which were subject to confirmation at the next meeting of the International Illumination Commission, which had unfortunately been postponed. Time was thus being lost, but they were trying to get on with the passing of these resolutions by means of correspondence. He felt that this was the lesser of two evils, however; it was better than nothing at all.

Mr. Wilson referred to the so-called "vicious circle"—no flying—no lights. This was true to a certain extent, but it must be remembered that light was only one of the aids to night flying. There were other serious difficulties that impeded, but could hardly be dealt with at this meeting. He would not like to say that the absence of light was holding up night flying. He admitted, however, that if there were more lights there might be more night flying. There was, however, one type of night flying they do not wish to encourage—the private owner. Flying by night must be done properly or not at all. He was not satisfied that the private owner is qualified to fly at night.

Mr. Wilson has suggested an Air Fund. He (Major Mealing) was not familiar with the working of the Road Fund, but if Mr. Wilson would suggest a way they would do all they could to put it through. In regard to the lamp changing, this was effected when necessary and without undue difficulties. He might, perhaps, say that in this field the gas engineer and the electrical engineer were in a measure rivals. The gas lights they had had in the past had been maintained and inspected only once a quarter. These lamps, to his knowledge, had only failed twice within the last six years. It was up to the electrical engineers to provide this standard. The lamps must be so safe that they did not require attention. It was not practical to have anything that needs attention constantly.

Neon boundary lights had been used in several countries, especially in Germany, and it had been suggested more than once that we ought to use them in this country. The reason for not using them was partly based on expense, but also the possible danger. So far as he knew no machine had come in contact with such lamps, but it would be dangerous if there was any petrol about. Obstruction lights were essentially different from boundary lights. It was necessary to show up the aerodrome, and if one could differentiate it was safer for the pilot. At Croydon they had flashing boundary lights, because the pilots could differentiate between red and orange. This question was discussed at Zurich.

Col. Evans raised the point about confusion of lights. There was a clause about this in the Air Navigation Order, and the Air Navigation Control Committee had taken this matter up. Col. Evans also suggested asking the views of pilots in regard to the choice of red or orange for boundary lights. He found, however, that if one went to pilots one got a different answer from each. Ask a hundred pilots, and you got ninety-nine different answers! I could not answer the question regarding visibility. The question as to whether searchlights can be seen through clouds he could only answer by asking another question—can you identify the type of searchlights?

In regard to landing lamps, the Germans had very little equipment on the ground; it was all on the machine. In this country opinion did not endorse this theory. It was considered that all the equipment should be on the ground, and it should not be necessary, therefore, to equip the machine with lighting gear.

Mr. Villiers had suggested getting the chief towns to supply the lighting for air routes. He did not know quite how one would set about this, and doubted whether at the present time they would be willing to do so. The Air Ministry was working on a scheme for the classification of aerodromes in this country similar to American ratings.

He was sorry if he had seemed to criticize Dr. Hampton's work in regard to the slide. He did not know that he had taken the photograph, and did not mean to suggest that the shadow bar was due to faulty manipulation of the camera. Mr. Stroud had been the only one to give him a possible explanation of the halo on the slide.

Mr. Norman had referred to the provision of lights for night flying on Empire routes. In regard to the wind indicators, tests by many observers had led to approval of the form adopted. The floodlighting of the landing grounds was no doubt the ideal system, as you then always had sufficient light to enable landing, but it was very expensive. The question whether vertical and horizontal beams should be of equal intensity had been answered in the paper. As regards people not wanting airway lighting, they need not have it if they did not want it. It had always been said that the train services in this country were exceedingly good, but the airway was undoubtedly the mode of travel of the future. For some distances airways could beat main-line trains hands down. For instance, it was much quicker to get to Scotland in this way. Cheap air travel was, he thought, coming before long.

The Fixed Light Equivalent of Flashing Lights

By A. K. TOULMIN-SMITH, B.A., A.M.I.E.E., and H. N. GREEN

THE range at which a flashing light is seen is dependent on the apparent intensity of the light, the brightness of the background against which it appears and the direction, relative to the light, in which the observer looks. In the case of a lighthouse or beacon the decrease in range due to the background brightnesses experienced at night may, for practical purposes, be neglected. Furthermore, since recognition of flashing character is essential, a lighthouse will almost invariably be observed by foveal vision. The useful range of a lighthouse, as distinguished from the range at which it is on the threshold of visibility, may therefore be defined as the range at which the light can be kept under continuous observation by foveal vision and at which the flashing character can be identified.

As a preliminary step towards the establishment of a method of estimating this range for any given light, a decision must be reached as to the minimum illumination required for adequate conspicuity. Since the ability to see a distant light depends on the illumination produced at the observer's eye, conspicuity may be conveniently expressed in candles/mile^2 and denoted by the symbol E_c.

Tests carried out by the authors*, under conditions closely resembling those experienced by aviators, gave a mean value for adequate visibility of 0.5 candle-mile^2. Correcting to allow for the

* Aircraft Engineering, Jan., 1931, 3, p. 12.

absorption by the goggles worn by the observers during these tests, the minimum illumination which should be assumed in calculating the probable range of a light is 0.425 candle-mile². This result is in close agreement with the value of 0.16 candle/kilometre² (0.415 candle/mile²) determined by the Deutsche Seewarte†.

According to Blondel and Rey‡ the threshold value of E_c may be as low as 0.13, and it may be anticipated that when the conspicuity of the light is raised to over three times the threshold, i.e., when the light character is readable, the diminution in apparent intensity due to flashing will not be the same as for a light which is only just visible. The tests described in this paper were undertaken to find a law which would give the fixed light equivalent of a flashing light at the practical limit of range, where $E_c = 0.425$ candle/mile².

The method employed was to view alternately a fixed light of known conspicuity and a flashing light of the same intensity. The intensity of the flashing source was then increased till the conspicuity of the flashing light appeared to be the same as that of the fixed light. The fixed light equivalent of the flashing light was calculated from the increase in intensity of the flashing light required to obtain a balance. The fixed and flashing lights consisted of illuminated pinholes, and were viewed with one eye only. As it was desired to obtain curves at definite conspicuity levels the question arose as to whether a point source is equally visible when seen with one or both eyes. The following preliminary experiment was carried out to settle this question:

Referring to Fig. 1, two illuminated pinholes were set up so that they could be viewed as though they were closely adjacent and equi-distant from the observer. Pinhole B was viewed by reflection from a sheet of clear plate-glass inclined at an angle of

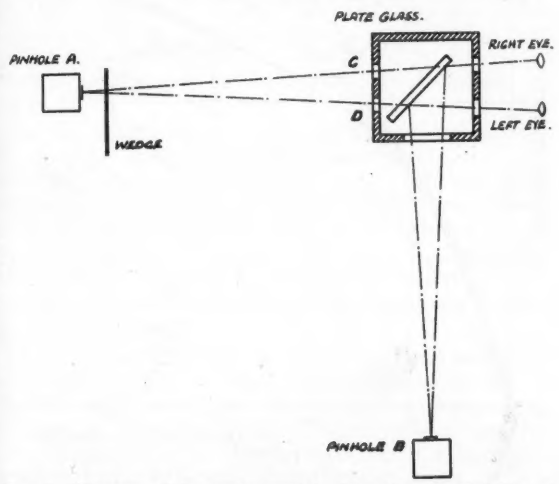


FIG. 1.—Diagram of Apparatus used to determine the visibility of the point source when seen with one or both eyes.

45° to the optical axis. This pinhole was always seen by both eyes. Pinhole A (of about one-tenth the intensity of Pinhole B) was viewed through the plate-glass, and its intensity could be varied by means of a calibrated wedge. This pinhole could be viewed with both eyes or with the right eye only by closing aperture D or with the left eye only by closing aperture C.

The apparent intensities of the pinholes were first adjusted to be the same when they were seen with both eyes. A setting for each eye separately was then taken on Pinhole A, using Pinhole B, seen with both eyes, as a standard of comparison. The results obtained are given in the accompanying table.

Observer	Intensity of pinhole A required to give the same apparent intensity as pinhole B.		
	Both eyes	Left eye	Right eye
A	1	1·6	1·04
(left eye defective)	1	1·61	1·03
B	1	0·95	1·22
(right eye slightly defective)	1	0·98	1·42
C	1	0·98	0·99
(both eyes normal)	1	1·12	1·04

The experiment proved that for an observer with normal eyesight the conspicuity of a point source is the same whether viewed by one or both eyes.

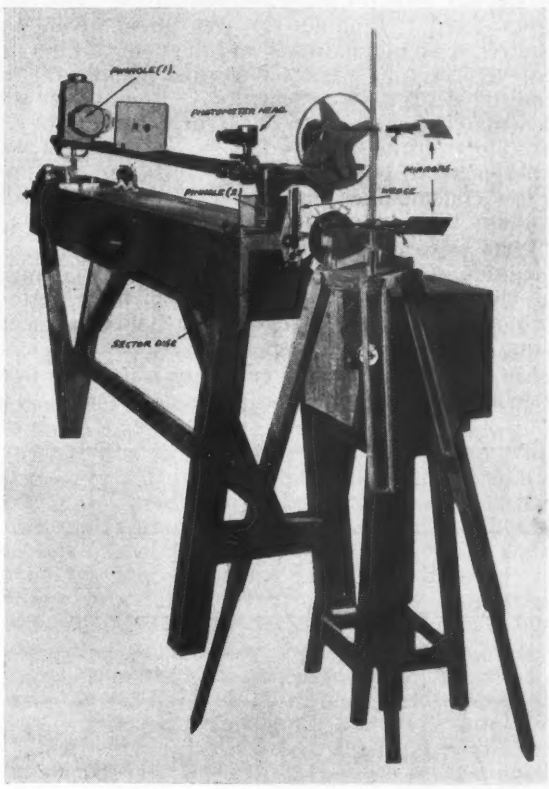


FIG. 2.

When the observer has defective eyesight the conspicuity for both eyes is that of the better eye. It was noted that in making the observations which are described later each observer naturally employed his better eye.

A photograph of the apparatus used for the fixed

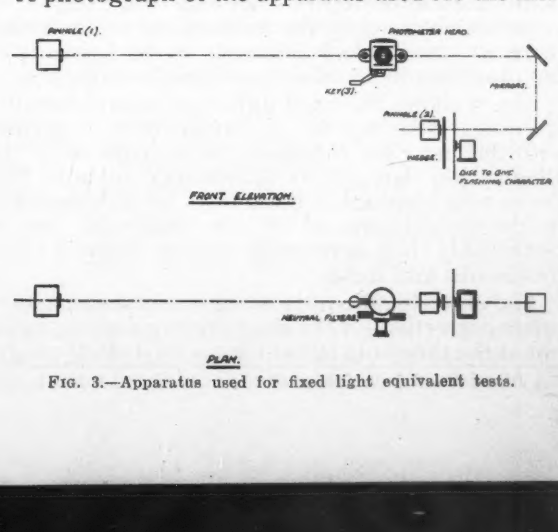


FIG. 3.—Apparatus used for fixed light equivalent tests.

† Publication reviewed in *Jour. fur Beleuchtung*, 38, 1895, p. 330.

‡ Rey, "The Application of the Blondel-Rey Law," Lighthouse Conference, 1929.

light equivalent tests is shown in Fig. 2, and the arrangement of the apparatus will be understood by reference to Fig. 3. The illuminated pinhole (1) was used as the fixed light and was visible in the centre of the field of view when the key (3) was depressed. When the key was released pinhole (2), which was given a flashing character by means of a clockwork-driven sector disc, appeared in the same position in the field previously occupied by pinhole (1). The brightness of pinhole (2) was controlled by a calibrated wedge, and the conspicuity level at which any given series of readings was taken was adjusted by neutral filters which were interposed in the eyepiece tube. Both pinholes were at a distance of 2.20 metres from the observer's eye and the fixed light pinhole had an intensity of 1.66×10^{-4} candle.

It will be noted that the fixed and flashing lights were not viewed simultaneously. The procedure was to first obtain several balances, at a convenient conspicuity level for accurate comparison, with both lights fixed. Pinhole (2) was then given the required flashing character and the neutral filters in the eyepiece tube were set to give pinhole (1) the required degree of conspicuity. Pinhole (2) was then matched with the fixed light by means of the variable transmission wedge. No difficulty was experienced in obtaining fairly consistent readings at low conspicuities, but above 1 candle/mile² the readings became less accurate.

Tests were made when the fixed light had conspicuities of 0.2, 0.5, 1.0, 2.0 and 4.0 candle/mile² for characters from 0,05 to 0.5 sec. flash period, with approximately 1 second dark interval separating flashes in each case.

Fig. 4. shows a typical curve for a flashing light of which the conspicuity is 0.5 candle/mile². The

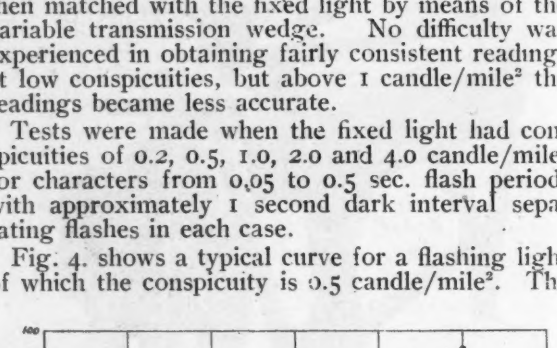


FIG. 4.—Fixed light equivalents when $E_c = 0.5$ candle-mile².
o Observer B.
+ " C.

points are shown to give some idea of the degree of accuracy obtained by the method and to show that there was no marked difference in the opinions of the observers as to what constituted a balance.

Fig. 5 shows the fixed light equivalents for conspicuities from 0.2 to 4.0 candle/mile², together with the curve for threshold visibility given by the Blondel-Rey law. It is satisfactory to note that the results obtained in these tests for a conspicuity in the neighbourhood of the threshold, are in remarkably close agreement with the formula given by Blondel and Rey§.

The object of the tests being to obtain an appropriate correction for the intensity of a flashing light, not at the threshold but at the useful limit of range,

§ Blondel and Rey, *Journ. de Phys.*, 1, (Aug.), 1911, p. 530.

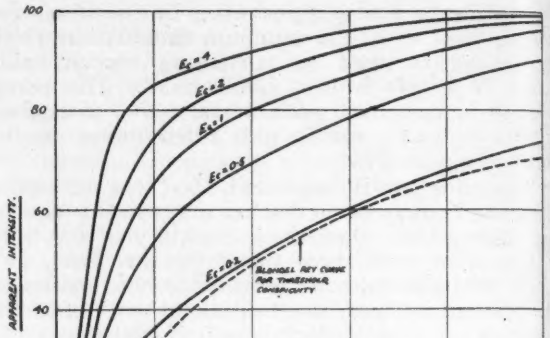


FIG. 5.—Fixed light equivalents at different conspicuity levels.

a curve has been drawn by interpolation which gives the fixed light equivalents when $E_o = 0.425$ candle/mile². This curve is shown in Fig. 6, and conforms approximately to the equation—

$$\frac{I_o}{I} = 1{\cdot}1 \frac{t}{0{\cdot}15 + t} \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where I_o is the apparent intensity and t the period of flash. A curve following the Blondel-Rey law

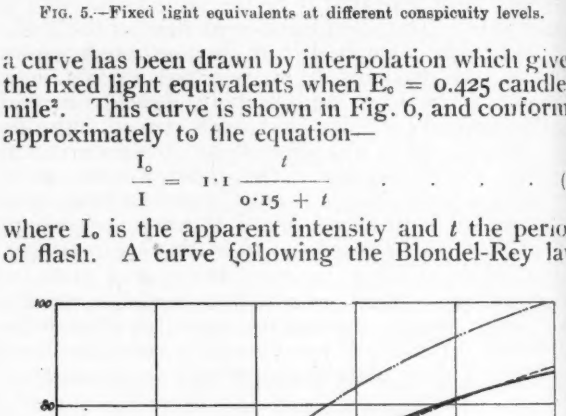


FIG. 6.

is shown for purposes of comparison, together with a curve obtained from the simplified expression proposed by Van Vloten*—

$$\frac{I_o}{I} = 1{\cdot}4 \frac{t}{0{\cdot}2 + t} \quad . \quad . \quad . \quad . \quad . \quad (2)$$

It will be seen that while equation (2) fits the observations up to a flash period of 0.1 second it is inaccurate for longer flashes.

There is little to choose between the two formulæ on the score of simplicity. Equation (1) is, however, in accordance with the experimental results over the full range of the observations and for practical purposes should give a sufficiently close approximation to the fixed light equivalent of flashing lights at the limit of useful range.

* Van Vloten Ve Congrès Internationale de la Navigation Aerienne. Sept., 1930.

The Lighting of Arterial Roads with Gas

THERE was an excellent attendance at the joint session of the Institution of Gas Engineers and the Association of Public Lighting Engineers, held in connection with the Public Works, Roads and Transport Congress at the Agricultural Hall, London, on November 14th.

In opening his paper on "The Lighting of Arterial Roads with Gas," Mr. A. M. Bell explained that he did not propose to delve deeply into technicalities, but rather to set out some of the obstacles with which a public lighting engineer had to contend in dealing with this problem. In the introductory part of his paper he touched briefly on the history of public lighting, recalling that about 200 years ago oil lamps and candles were the only means of street lighting, and these had to be provided and maintained by private owners; to this day some of these lamps may be seen over gateways or on brackets attached to the walls of some old buildings. Another agent of street lighting was furnished by the "link boys" who were employed to guide pedestrians to their destinations.

Just over 100 years ago came the first great stride towards making our streets safe for law-abiding citizens. This was the utilization of gas for street lighting. In 1812 Pall Mall was lighted, and "people flocked to see the wonderful new gas lamps." It was not, however, until the year 1880 that the first gas mantles were used. Gas had been in use for practically 73 years when the electric lamp came into the field.

To-day, Mr. Bell proceeded, some of our great thoroughfares might be described as magnificently lighted, some good, some bad, some deplorable, and others not lighted at all; nevertheless, in England it was in every case the ratepayers who met the bills for street lighting. In America, on the other hand, in some of their famous streets magnificent and decorative street lighting is provided by voluntary taxation of the owners of properties fronting the streets.

Arterial roads as we know them are constructed for specific purposes, namely, to make short travelling distances between towns, to divert traffic from busy shopping centres, or to by-pass towns. Mr. Bell proceeded to describe the treatment of one of these arteries, namely, the Great Cambridge Arterial Road which runs through the centre of the area of supply of the undertaking with which he was happily connected.

This road was opened to traffic approximately ten years ago. The overall width is made up as follows: 16-ft. footway, 24-ft. carriageway, 10-ft. grass verge, another 24-ft. carriageway and another 16-ft. footway. The down road has not yet been completed and is at present a grass sward. The road passes through the areas of five local authorities and two counties, and in all is $10\frac{3}{4}$ miles in length, cut in places by main and secondary cross-roads, and in one place by the North Circular Road. When the road was first opened one could traverse the whole length practically without passing a house, factory or building of any sort, and certainly no street lamps. Traffic was extremely light and there was no necessity for point policemen. It was not long before the existence of the road became widely known, and gradually the traffic increased and house building commenced. Then it became necessary for point policemen at various junctions, and a few street lamps were erected at dangerous crossings. The road grew, more houses were erected, then a Council housing estate and some factories were built, and as was only to be expected, accidents occurred. Sample gas and electric lamps were erected for the Council's inspection in one area, but it was not until 1927 that any public lighting scheme matured. This was carried out in Tottenham, where twenty-seven 6-light upright-fixing gas lamps were erected on 14-ft. columns, carrying the light-source to 16 ft. above ground level, the standards being spaced 100 ft. apart in line on the grass verge in the centre of the road. It was shortly after this time that trees were planted 60 ft. apart on each footway throughout the length of the road. Traffic had now increased enormously, and in a comparatively short stretch it became necessary for point policemen to be placed at four crossings. The illumination of these policemen was one of the first real difficulties to be tackled, and in three instances this was overcome by erecting two gas lamps at each junction, each lamp fitted with a bullseye which directed a beam of light on to the officer, but in the fourth case we experienced trouble. In the first three cases there were buildings skirting the road, but in the latter, which is at the junction of five roads, conditions were different, for here there were no buildings at all. Lamps were erected, positions altered, spot lights attached and many experiments made, but the policeman was still not visible at any reasonable distance, for his dark uniform was lost in the dark background. The trouble was obvious, but how to overcome it was another matter. An effort was made to persuade the owner of some vacant land to give permission for an advertising hoarding to be erected which would act as a background for the policeman, but such permission would not be granted. At big expense this great junction was altered, all roads were thrown open wide and an island refuge erected in each neck with a 10-light gas lamp and two bollards fitted with reflex boxes. This alteration tended to slow up the traffic at this point and make traffic control easier. It was at this time that another Council decided to light sections of the road in their area, which were skirted by houses, and extend the lighting as building proceeded. Traffic was by this time increasing rapidly and accidents were numerous.

This description shows how rapidly conditions changed from the time when the road, practically deserted, wound peacefully through fields and open spaces, traversed by few and inhabited by none, to the present day when no less than 4,927 vehicles were officially recorded as having passed one point in 16 hours. Changes are still taking place, the point policemen previously mentioned have all been withdrawn and traffic-operated signals have been installed in their places. The huge junction which cost so much to open up and widen is again being altered and the wide open roads are being narrowed for the construction of a gyratory traffic system. With the advent of this alteration one more Council has adopted gas lighting for the whole of its area and another completed the lighting of its section.

This road passes through five different Council areas, and the following details are interesting for comparison:—

Council.	Length of Road.	No. of Lamps required.	Population of Town.	Rateable Value.
A	2,035 yards	63	158,800	£883,687
B	375 ,,	9	54,520	£457,673
C	4,700 ,,	101	78,800	£437,074
D	5,280 ,,	120	67,869	£505,869
E	5,715 ,,	130	14,651	£80,917

The road is primarily used for vehicles, and as it by-passes all shopping centres it cannot be said to bring trade to any neighbourhood. On one section only is it completely built upon. On section E

there is practically no building at all, and it will be noticed that this Council, with the lowest rateable value, has the longest section of the road to light. This is an exceedingly heavy burden for the ratepayers in that district to bear, and emphasizes the reasonableness of the contention that in such cases the authority through whose area the road passes should receive some assistance in meeting the costs of lighting. The death roll of the road is heavy, and surely this fact alone should emphasize the necessity of good and adequate street lighting. The local Councils are the lighting authorities and the ratepayers are expected to foot the bill for lighting a road which is of little or no interest to them.

Mr. Bell contended that good street lighting is as necessary and as important as any other public service, and is one of paramount assistance to the police in their work of maintaining law and order. The cost of installations and the annual expenditure cannot be borne to the same extent by a country town as it can by a wealthy city, neither can a comparatively few residents be expected to contribute by voluntary taxation a large sum, when they already pay for public services. All roads in the country should be graded, the necessary lighting correspondingly graded, and the expense of same paid out of a common fund to be contributed to by all local and county authorities, and to include a considerable contribution from the road fund.

To all intents and purposes the lighting of the road so far is uniformly carried out by clock-controlled 6-light No. 2 upright-fixing low-pressure gas lamps with mantles in staggered formation, erected on 14-ft. columns spaced 130 ft. apart in line in the centre of the road, the average ground illumination is 0.25 foot-candles, the maximum 1.22 foot-candles, and the minimum 0.055 foot-candles, height spacing ratio 8.125—1 and the diversity factor 22.18. Class "F," B.S.I. Specification.

All important road junctions are illuminated by 10-light lamps of the same pattern and mounting height. The more recently fixed lamps are fitted with 24-in. diameter flat enamelled steel shades and multi-faced reflectors clipped on to the uprights. These latter attachments add considerably to the efficiency of the lighting. The light is soft, with a total absence of glare. In this connection Mr. Bell mentioned an experience which shows how deceptive "light" is. After people have inspected lamps, first in a road lined with houses on both sides and then one with open fields on either side, the opinion expressed is always that the lighting of the street lined with houses is the better, when actually, as proved by the photometer, it is far from being the case. An installation in one street might be considered admirable, but an identical installation in another type of street would be considered poor. Moreover, the average man in the street thinks that if he sees a glare that it is a good light.

Mr. Bell next touched on one or two details which must be considered when preparing a scheme for the lighting of an arterial road. Unfortunately, for the reasons stated above, in the majority of cases the first point is capital cost and annual charges—these two items as a matter of necessity must be cut down to the lowest possible figure. The next point is to look into the future and ascertain what buildings (if any) will be erected on either side of the road, and whether the road at some future date will have to be widened. If there is no possibility of shops or houses, a high grade of illumination must certainly be provided, for no aid from reflection or assistance from outside sources will be obtained. Another necessity is uniformity of lighting over the whole length of the road, for there is nothing so dangerous or trying to drivers than to run from a well-lighted section into an unlighted black patch or into another section with a totally different scheme which may give bad visibility.

There are several pitfalls which must be guarded against. The chief of these is found when there are sections of road lighted only on the inside of a bend. A dry section of road so lighted may not appear troublesome, but directly the road becomes wet we get specular reflection or streaks of reflected light running from the observer to each light-source, and as the lights would be situated away from bend of road, the whole surface would appear to be black, with no possible hope of reflection or silhouetting as an aid. To overcome this difficulty, however high or low the category of illumination may be, lamps placed on both sides of the road are necessary. This question again arises on highly polished road surfaces.

Next, the minimum height of the light-source recommended under the B.S.I. Specification is infinitely preferable for this type of road lighting on account of silhouetting, which, although it should not be necessary, is in fact a very great assistance to drivers of vehicles in rough weather, mist or fog.

Another difficulty with which a public-lighting engineer has to contend is the presence of trees planted close to kerbs. On the road trees were planted 60 ft. apart 3 ft. in from the road face of the kerb. The trees are of the large type, namely, poplar, chestnut, etc., and in the few years that they have been planted, some have already grown from 20 ft. to 30 ft. high. In a section of the road, in the early days, one of the Councils decided to have lamps erected on the footways, and the lighting was quite good, but the trees grew to such an extent that practically all road illumination was cut out, and at considerable expense the position of the lamps had to be moved to the centre of the middle grass strip. Another common fault is to suspend a lamp in the centre of a road junction immediately over a policeman. This method is entirely wrong in itself, for the light from the lamp merely illuminates the policeman's helmet, and the majority of the figure is in shadow. It is agreed that a lamp suspended over the centre of a wide road junction is certainly very advantageous as a means of obtaining uniformity of road illumination, but it is necessary to have the assistance of side lights to illuminate a point policeman. Here again a screen or background is a great aid.

On the road there are a large number of signs such as "Cross Roads," etc. If such signs are considered necessary by day, how much more necessary is it that they should be illuminated by night? If a road is not lighted at all it is imperative that at least every road sign should be illuminated. Mr. Bell said that he had used every endeavour to further this point, but here again comes the question of the responsibilities of authorities; so far he had only been successful in a very few cases, although it is a subject which he had been trying to emphasize for years.

The lighting of refuges and bollards or guard posts is another item which has received special attention. A refuge is an obstruction deliberately placed in a thoroughfare, and for this reason alone the greatest care must be taken in selecting the means for lighting it. The bollards should also be illuminated to give every assistance to drivers of vehicles, and reflex signs can be adopted with great advantage. There are also certain details which should receive every attention in the lighting of a "roundabout" or gyratory system. In a scheme of this nature many signs or directional notices such as "Keep Left" or "Turn Left" are necessary, and

on most arterial roads the centre island, which, although guarded by railings, bears no further obstruction. All lights should be shaded from every point of visibility other than in the road or island refuges, thus leaving the illuminated signs clear and distinct.

Until comparatively a short time ago dark patches were visible between lighting units. These dark patches are in reality contrasts of light between the maximum and minimum road illuminations. To overcome this unevenness of illumination, reflectors or refractors are being found of great assistance, but care must be exercised in the selection of one or the other or of the combination of both, in avoiding too directive lighting which will produce "spot-light" effects. There is nothing worse to a driver than having to drive through a road and to constantly have his attention distracted by flashes of light, especially in bad weather when windscreens are wet and each drop of water acts as a bullseye to momentarily blind the vision of a driver at each flash. Reflectors and/or refractors when properly applied are of very great assistance in obtaining a more even distribution of light.

The question of maintenance is another matter of considerable importance. Nothing is more necessary in street lighting than the very highest degree of maintenance service. Nothing does more to harm the merits of either gas or electricity than bad maintenance. A drop of 20 per cent. in efficiency may easily occur by a comparatively small amount of dust and dirt on glass or reflectors, whilst anything up to 50 per cent. efficiency drop may be experienced after neglect of cleaning for a period of a few weeks. Dirty glass or dirty reflectors ruin the efficiency of any installation. Good maintenance pays for itself. Whilst on the subject of maintenance, there is one point which is not widely known, which is that a gas mantle instead of diminishing in illuminating power often actually increases in efficiency up to 1,000 lighting hours, and so with good maintenance a gas installation should not deteriorate.

The technique of modern street lighting is becoming exceedingly high, and it is not only necessary, but essential that every public lighting engineer should be thoroughly experienced in all its branches, not merely conversant with any one form of illuminant, but trained to the technical and practical possibilities of each in the effort to attain a much higher standard of street lighting, which is so necessary in these days of fast-moving traffic.

In conclusion, Mr. Bell said that he had tried to be impartial in every way, and had made no comparisons beween any forms of road illumination. Fair competition was good for one and all, and undoubtedly, the great strides which street lighting has made have been speeded up by competition to the benefit of the industries concerned and the public in general.

DISCUSSION

Mr. Harold Davies (Chesterfield), in opening the discussion of Mr. Bell's paper, said that he would leave to technical experts the consideration of the more intricate points raised. He wished to emphasize one very practical difficulty—namely the problem of obtaining money for installations on arterial roads. Authorities invariably wanted to know exactly what they were going to get in return for expenditure on street lighting. In the case of arterial roads, which often served mainly the needs of travellers outside the district traversed, a parish council's lighting committee was often disinclined to expend money unless they got some direct return; and in any case they would have great difficulty in finding funds—since sections of arterial roads had no houses along them and there was no rateable value. It was evident that a different mentality was needed and a new basis for the allocation of funds. In such cases the County Authority or the M.O.T. might well be expected to make some contribution. It had also been suggested that users of the arterial roads, such as the bus companies, might contribute to the cost of lighting. He wished to compliment Mr. Bell on his paper and congratulated the Association on arranging this meeting, which he hoped would have some influence on those who had control of the finances of public lighting.

Mr. G. H. Wilson congratulated Mr. Bell on his paper. He would like to refer to one or two general principles. Firstly in regard to the spacing and placing of posts. In his experience the method adopted by Mr. Bell was not really a satisfactory solution of the arterial road lighting problem—not because of the illuminant—but because of the arrangement of the posts, which were confined to one side of the road only. He and his colleagues had carried out a full-scale experiment on the placing of posts (with the co-operation of Mr. Gregory of the North Metropolitan Supply Co.) and had found that it was almost impracticable to get adequate lighting of the entire roadway with the posts arranged in this way.

To illustrate the point, Mr. Wilson showed a lantern slide of the installation on which the experiments had been made, with the posts mounted on one side of the road. The spacing was 139 ft. and the mounting height 25 ft. There was a region of high brightness on the side where the lamps were situated in which visibility was good, but on the other side the road appeared dark although the minimum illumination was three times that in the Cambridge arterial road. It was possible to see even in the dark part of the road, if the observer spent long enough looking, but it was not easy to see with certainty at a glance. As a contrast Mr. Wilson then showed a second slide with the lamps staggered on both sides of the road, so obtaining a bright region in both traffic lanes. This installation entailed double the running cost and so a third slide was shown in which the average spacing between the posts was doubled. The visibility in this installation was stated by Mr. Wilson to be greater than with the single-side installation although the running cost was the same.

Mr. Wilson said it was a great pity there was no test for visibility. In his opinion, for arterial road lighting under modern traffic conditions, such light was required that a driver felt confident he could see in the distance even a cat crossing. With this in mind, he had made some experiments with life-size models of cats executed in wood and painted either black or grey, and having reflection factors respectively of 5 per cent. and 15 per cent. These models were placed on selected spots on the roadway and their appearance furnished a test of visibility.* Lantern slides were exhibited showing that the two cats were both clearly visible. Mr. Wilson said this was the case not only on the sides of the roadway where the brightness was greatest, but also in the centre of the road, where it was evidently much less. Here, however, the grey cat had nearly disappeared but it was just darker than the background.

Mr. Wilson also drew attention to the way in which the road reflection properties could affect the

* Photographs illustrating the application of this method are reproduced in connection with the correspondence, Mr. Wilson's contribution to the Correspondence columns on page 316.

road brightness. The slides showed how, when the road had been tarred and sanded, the brightness had been materially decreased although the road surface was lighter, as seen in daylight. Some modern asphaltic road surfaces had excellent reflection properties, and Mr. Wilson urged that authorities should be well satisfied that surface treatment was necessary before the valuable reflection properties were lost.

Mr. J. M. WALDRAM also congratulated the author upon his paper, especially on the attention which he had paid to surface brightness. It was becoming more and more realized by street-lighting engineers that surface brightness was of much greater importance than illumination. He instanced model experiments which confirmed Mr. Wilson's remarks upon the post arrangement. With single-side lighting it was practically impossible to cause the far side of the road to appear sufficiently bright, even if the illumination were high, and if the road appeared dark it was impossible to see objects easily. He drew attention to the very different reflecting properties often possessed by the same surface when wet and dry. With some surfaces the change which took place when the surface was damp was less than with others, and they remained not too highly polished—a property of great importance to lighting engineers. Mr. Waldram showed slides illustrating this effect. It had sometimes been suggested that the use of a top dressing employing such materials as white chippings might be an advantage, but he had found in some cases that the loss of polish outweighed the whiteness, and the surface appeared far darker than before. He urged that road engineers should give consideration to the optical properties of the surface in their search for improved dressings, for the safe use of the roads involved the ability to see not less than freedom from skidding.

Mr. BYASS (Bridlington) drew attention to the numerous factors affecting street lighting. Certain improvements, such as the planting of trees at the sides of arterial roads, were considered inconvenient from a lighting standpoint.

Mr. ROGERSON (Worsley) remarked that there was a need for guidance in regard to the best methods of lighting arterial roads, and much disagreement on fundamental principles. He had been told by some motorists that they preferred such roads to be unlighted. He wished to endorse the remarks of Mr. Davies in regard to financial difficulties. In his own district there had been much difficulty in determining who was really responsible for the lighting of a new road, where, at present, there was no rateable value. He was interested in the suggestion that large users of the roads—such as the bus companies—should contribute to a fund to defray the cost of lighting.

Mr. W. H. GREGORY (Wembley) said that he agreed with many of the conclusions in Mr. Bell's paper. There was evidently room for discussion on the positions of lamps; he recalled that Sir Malcolm Campbell, in an article in the daily press, had advocated central suspension. This method, however, required two supports, and columns were admittedly obstructions. Mr. Wilson had already dealt adequately with one other point he had wished to raise—the influence of the road surface and the drawbacks of tarring. He recalled that Mr. Paterson had mentioned this matter at a previous conference. He agreed that it was inexpedient to suggest a lower mounting height. The height mentioned in the B.S.I. Specification was a definite function, which should be adhered to. He noticed that Mr. Bell had not referred to some of the most recent types of fittings and directional effects. He thought that unidirectional lighting might play an important part in the future lighting of arterial roads.

Mr. F. C. SMITH said that he would like to join with others in congratulating Mr. Bell on his excellent paper. He himself felt that as yet we knew very little about street lighting in general, and this was especially true with regard to the lighting of arterial roads. He was much interested in the remarks of Mr. Wilson and Mr. Waldram. He was not sure if he understood Mr. Wilson if he meant that equality of brightness was the main thing to aim at. He (Mr. Smith) was not at all sure of the correctness of this view. There were many factors other than quality of brightness and the reflection characteristics of the road surface which were of importance in influencing visibility. An arrangement had recently been made with the Town Council to allow a road to be used for experiments, provided that a given illumination was always maintained. He agreed with Mr. Waldram in regard to the appearance of the road surface under day and night conditions, but he felt that the appearance of road surfaces under artificial light might be in some way connected with the colour of the light incident upon the road surface. He had been interested in the suggestion that the luminous output of gas mantles increases with time. It was a fact that there was an increase from the initial value after a certain period of time. He felt there was a great deal more to be done if the factors influencing visibility were to be understood and assessed, and he welcomed conferences such as they were attending, as they offered opportunity for exchanging views, and should do much to promote a better understanding of the requirements for street and arterial-road lighting.

Colonel OAKES (National Safety First Association) said that some of the lighting to-day was good and some moderate, but much was deplorable. He wished to draw attention to the tendency for accidents occurring after dark to increase. It had been stated that about a third of the number of such accidents was due to bad lighting.*

Mr. L. T. MINCHIN (Gas Light & Coke Co.) expressed the hope that Mr. Langlands would be able to say something about visibility and road surface reflection, since he had studied it in some detail. He was not sure whether Mr. Wilson's experiments with cats were of much use when applied to human beings, since a figure the size of a man usually had a non-uniform background, and therefore could not disappear into the background in the way that a cat might.

It had been suggested that poor lighting was worse than none at all on arterial roads. He did not agree with this, since even a low order of illumination served to raise the adaptation level of the eye and make it less susceptible to glare from headlights. Mr. Stiles, of the National Physical Laboratory, had shown that the disability glare from a given position was reduced to one-quarter even by Class H lighting.

Mr. W. J. JONES rather regretted that the meeting had been confined to gas lighting, and that the other illuminant had been left out! He had, however, watched Mr. Bell's work with interest for some

* Interesting conclusions on this point are to be found in our recent analysis of the useful records compiled by the National Safety First Association (*Illum. Eng.*, July, 1933, pp. 174-176.)

time, and had been impressed by what he had done. There were just a few points on which he would like to comment. He doubted whether it was expedient to try to do two things at once—i.e., to use one device both to light the road and to serve as a traffic sign. It seemed to him that in such cases one of the objects aimed at was likely to suffer. Lighting from one side of the road only, which usually involved the use of an unsightly bracket projecting over the roadway, should be regarded only as a temporary measure. In regard to the lighting of police officers on point duty the ordinary method of "spot lighting" was not very effective. Floodlighting was really necessary.

Mr. S. B. LANGLANDS (Glasgow) congratulated Mr. Bell, and proposed a vote of thanks to him for his paper. He also expressed the thanks of the meeting to Mr. Severn for presiding. The paper had been a most interesting and lucid one. He was interested in the record book, dated 1857, which Mr. Bell had shown. Systematic keeping of records was of great importance. In Glasgow they had a record book that went back to 1801. He agreed that the lighting of arterial roads was a national question, and it should not be left to the efforts of small bodies. The Ministry of Transport had already undertaken responsibility for the roads, and they should also be concerned with the lighting. Reference had been made to the relation between lighting and accidents. This was a somewhat complex problem; he could mention roads that were well-lighted, and yet the accidents increased—possibly because a well-lighted road led to greater speed of traffic.

Mr. A. M. BELL, in reply, thanked those present for their reception of the paper. Mr. Davies had referred to the difficult question of meeting the cost of lighting installations on arterial roads. So far, in this case the lighting had been provided by the local authority, but he knew that deputations had been sent to the Ministry of Transport with a view to securing assistance in that quarter, but without success.

He agreed with Mr. Wilson that lamps on both sides of the road were desirable in principle, but in practice the question of cost often determined that decision. The initial installation was more costly, as one needed twice the number of lamps. He thought, however, that he had shown that even with unilateral lighting, good results could be obtained.

Mr. Wilson was not the only one who experimented with dummies! On the Cambridge road several kinds of models had been used; the policeman, for instance, that figured in some of the photographs was a dummy, and had since been returned to a tailor's shop. He thought that Mr. Wilson would agree that his cats appeared visible against a bright background, and this illustrated his (Mr. Bell's) point about the value of "silhouetting."

He also agreed with Mr. Waldram about the mounting heights of lamps on roads generally, but not on this particular road, and contended that each road should receive separate consideration according to local environment and requirements.

In reply to the other speakers, Mr. Bell explained that lamps with bracket arms or centrally suspended lamps would be better, but here again the question of cost ruled such schemes out of the question.

In regard to Mr. Rogerson's suggestion, it entirely depended on the type of road whether artificial lighting was expedient. Roads used only by motor traffic might be left unlighted; but should not be badly lighted. He agreed, however, that roads used by both traffic and pedestrians should certainly be well-lighted. As regards the cost, Mr. Bell stated that he had emphasized very strongly in his paper his ideas on this subject.

Mr. Jones deprecated the use of the same lamps to light road signs as well as the roadway. He (Mr. Bell) wished to point out that the signs illustrated, as well as very many others, were lighted entirely separately; were complete units in themselves, and did not in any way interfere with the street lighting; in fact, they were an addition and a great asset.

He agreed with Mr. Langlands that ancient records should be preserved, and in this connection he knew that the Chairman (Mr. Severn) had a most interesting collection.

Notes on Exhibits at the Public Works, Roads and Transport Congress

AT this Exhibition there were, as usual, not many exhibits bearing directly on applications of light. Such displays may be divided into two main groups, comprising (*a*) public lighting equipment and (*b*) directional and traffic signs and signals—sections of almost equal interest to the public lighting engineer of to-day.

ELECTRIC DISCHARGE LAMPS.

In the first group the new electric discharge lamps, which are now attracting so much attention, naturally figured.

The display of the BRITISH THOMSON-HOUSTON CO. LTD. included the Mazda "Mercra" lamp. These lamps were shown in fittings both of the "directional" and the "circular" type, which figured in the installations erected by the company in connection with the recent annual conference of the Association of Public Lighting Engineers in Margate. The "Escura" figured at the stall of the EDISON SWAN ELECTRIC CO. LTD. New forms of directional fittings, such as the "City" and "Enfield," were on view. These illustrate the departure from conventional forms of street-lighting units characteristic of units designed for the electric discharge lamps, being approximately cubical in shape, and combining lightly diffusing or prismatic glass panels with directive reflectors. At the stall of the GENERAL EELECTRIC CO. LTD., similarly, the new "Osira" electric discharge lamps, with their original and specially designed lanterns, were naturally a leading feature. The use of such lamps for colour-floodlighting and the "Wembley" (both open and enclosed) lanterns uitlizing Osram lamps were also demonstrated.

GAS LIGHTING.

Gas lighting was well represented at the stall of W. PARKINSON & CO., where the "Parkinson" series of pre-heated inverted burner lamps suitable for public lighting were on view. The recently designed "flood-lite" projectors, equipped with chromium-plated parabolic reflectors enabling gas to be applied for the floodlighting of buildings, were

also exhibited. Another type of "flood-lite" lamp (one really wants a more distinctive title here) utilizes a series of ten mantles in alignment, and this too is capable of good results, though naturally giving a more dispersive beam that the projector. What struck one as a specially commendable feature at this stall was the exhibition not only of polar curves of light-distribution of the various lamps, but also isolux and isocandle diagrams. Such curves are specially useful in showing the effect of the "Mor-lite" directional reflector, which, at first sight, would appear to have little effect on the performance of the lamp as a whole, but does in fact increase the candle-power very materially at the point where an increase is most desired. Reference should also be made to the company's danger lamps with ruby globe, which may be conveniently combined with traffic warning signs.

After referring to gas lighting it is natural to turn to the stall of the HORSTMANN GEAR CO. LTD., who are usually to be found in the foreground where public lighting is being illustrated. Appliances for the automatic control of both gas and electric lamps were on view. There is no need to emphasize the advantages of such automatic control. Savings in maintenance costs of from 12s. to 20s. per lamp per annum are said to be effected by such means. The Newbridge catalytic torch ignition controller (which entirely dispenses with the use of a bypass except for a few minutes at the time of lighting) was also in evidence. One was glad to hear that the good impressions formed when it was introduced have been well fulfilled. The application of Newbridge gas switches to the control of gas-fires is effectively illustrated in a recent booklet. Another novelty, a product of the Research Department of the Gas Light & Coke Company, is the new G.L.V. safety cut-off, for which the Horstmann Gear Co. Ltd. are sole licensees and manufacturers.

The TILLEY LAMP CO. exhibited the familiar Tilley portable incandescent lamps and floodlight projectors burning paraffin vapour. Of the value of these types of lighting in country districts where neither gas nor electricity may be available there can be no question.

AUTOMATIC TRAFFIC CONTROL.

The duties of a public lighting engineer now so frequently involve the supervision and choice of illuminated traffic signs and the provision for luminous traffic-control signals that this section of the Exhibition can by no means be ignored. This is indeed a subject that seems to have "grown up in a night" and is still developing rapidly. The Exhibition was an eye-opener in showing how many are the firms who now produce apparatus of this kind, and we can only single out a few for special mention.

Great interest was shown in the well-equipped stall of AUTOMATIC ELECTRIC CO. LTD., at the corners of which a series of full-size three-colour light-signals were exhibited. The Electromatic system has been made familiar by the installation in Trafalgar Square and Piccadilly, and its characteristics were ingeniously illustrated by means of facsimile road intersections, complete with miniature signal lights and road detectors—reproducing in a small compass conditions actually met with in practice.

At the stall of the GENERAL ELECTRIC CO. LTD., likewise, the actual working of a new traffic-control system, the "Autoflex", was shown in miniature—a typical business centre—the Elephant and Castle intersection—being thus reproduced. The characteristic of this system is that the "Autoflex" mats contain no electrical contacts or connections. Each mat embodies a steel trough, encased in heavy rubber moulding. As a result of pressure by a vehicle, air is driven to a contact box, where the pneumatic impulse is converted into an electric one. At this stall illuminated road signs of various kinds and a complete street refuge with illuminated bollards was on view.

LUMINOUS TRAFFIC SIGNS.

Messrs. HAILWOOD & ACKROYD LTD. are best known to readers of *The Illuminating Engineer* for their illuminating glassware produced in such variety at their Morley works. Their exhibit on this occasion, however, served to show how they have branched out into this new field of traffic apparatus. Amongst the objects on view were directional signs, traffic yellow, red, and green cylinders and globes, illuminated island platforms, lettered globes and illuminating glassware for public buildings.

Exhibitors of traffic signs were, as stated above, numerous. We must confine ourselves to mentioning two, which seemed to be of special interest. We will mention first the very representative display of GOWSHALL LTD., who had two stalls in the Entrance Hall and Gilbey Hall respectively. This firm may justly claim to have made a name for themselves in this special field. Their lists cover metal road letters and safety lines and studs, warning signs for road repair work, bus stop signs, and street name-plates, as well as numerous forms of traffic signs and mandatory signs which fulfil the latest Ministry of Transport requirements. (The mere enumeration of these signs shows how this special field of work has recently developed). If one may single out one section as of exceptional interest, it is the illuminated guard posts with which this firm is identified. One of the latest designs, the "Guardian Angel," which can be utilized either with gas or electric lighting, struck one as particularly serviceable, the illuminated inclined surface below and the illuminated sign above making a very happy combination. The firm also devotes attention to island refuges. One was interested to see new designs in stone and granite—a more pleasing medium for rural areas than painted metal. As regards material for signs one was impressed with the new "traffolyte" fadeless designs which Messrs. Gowshall Ltd. are introducing. These signs are non-metallic and yet practically indestructible. The back is of compressed plastic material into which the design (which may be of any colour) is pressed and then protected by a transparent coating. A very efficient sign is the result of this process, which is typical of the new methods now being introduced.

Another firm whose exhibit impressed one by its variety, and whose activities do not seem to be as widely known as they deserve, was that of the BRIGHTON ELECTRICAL LIGHTING AND ELECTRICAL ENGINEERING CO. LTD., who handle industrial and street lighting lanterns and pillars, and also traffic signs and illuminated island refuges.

Finally, one would like to spare a word for the exhibit of the CARDIFF FOUNDRY AND ENGINEERING CO. LTD., who likewise make a feature of mandatory, directive and other traffic signs. The semi-polished surfaces given to some of these designs appeared to be very effective, and one was struck by the "pillar of fire" illuminated guard-post, which is now a familiar feature on the Victoria Embankment, and, as its name suggests, is a form of illuminated traffic guide which no motorist could fail to see.

Literature on Lighting

(Abstracts of recent articles on Illumination and Photometry in the Technical Press)

Abstracts are classified under the following headings: I, Radiation and General Physics; II, Photometry; III, Sources of Light; IV, Lighting Equipment; V, Applications of Light; VI, Miscellaneous. The following, whose initials appear under the items for which they were responsible, have already assisted in the compilation of abstracts: Miss E. S. Barclay-Smith, Mr. W. Barnett, Mr. S. S. Beggs, Mr. F. J. C. Brookes, Mr. H. Buckley, Mr. L. J. Collier, Mr. H. M. Cotterill, Mr. J. S. Dow, Mr. J. Eck, Dr. S. English, Dr. T. H. Harrison, Mr. C. A. Morton, Mr. G. S. Robinson, Mr. W. R. Stevens, Mr. J. M. Waldram, Mr. W. C. M. Whittle, and Mr. G. H. Wilson. Abstracts cover the month preceding the date of publication. When desired by readers we will gladly endeavour to obtain copies of journals containing any articles abstracted and will supply them at cost.—ED.

(*Continued from Page 273, November, 1933.*)

II.—PHOTOMETRY.

310. Subjective or Objective Photometry? H. Schober.

Die Lichtechnik, p. 33, October 29th, 1933.

The relative merits of subjective photometry (based on the eye) and objective photometry (using a photo-electric cell) are discussed. In many cases the latter presents advantages such as greater speed of work and the possibility of results being seen simultaneously by a number of people. The chief drawback is the complex and relatively heavy apparatus. Photometric processes fall into four main groups concerned with measurements of (1) candle-power, (2) flux and illumination, (3) tests of weak intensities, and (4) tests of sources differing in colour. The two first groups are usually most suited to objective and the last two to subjective methods. J. S. D.

311. Sight Meter. H. G. Schiller.

Light, 3, No. 1, p. 11, Fall, 1933.

A photograph and a description are given of a new portable photo-electric photometer. The scale of the indicating instrument is not only calibrated in foot-candles, but also bears indications of the suitability of the various values for different purposes. C. A. M.

III.—SOURCES OF LIGHT.

312. An Improvement in Lamp Construction. Anon.

El. Review, Vol. CXIII, No. 2919, p. 628, November 3rd, 1933.

Describes an improved method of forming the "pigtail" of the filament support wires of tungsten-filament lamps, which avoids short circuiting a short length of filament if the lamp is inverted. J. M. W.

313. New Photoflash Lamp. R. E. Worstell.

A new American photoflash lamp, about the size of a 40-watt lamp, is now available. A photograph and particulars are given. C. A. M.

314. A New Signal Lamp. H. G. Schiller.

Light, 3, No. 1, p. 31, 1933.

A new signal lamp has two filaments connected in parallel, but separated by an opaque screen. When housed in the fitting the plane of this screen is coincident with the street axis. If one filament fails half the lens becomes ineffective, and the need for lamp replacement is thus indicated. Photographs are given. C. A. M.

315. Electrical Characteristics of the New "Osira" Lamp. J. W. Ryde.

G.E.C. Journal, IV, pp. 199-207, November, 1933.

A detailed study is given of the characteristics of the "Osira" lamp under starting and running conditions. C. A. M.

316. Ultra-violet Lamps. Ward Harrison.

Light, 3, No. 1, pp. 14-15, Fall, 1933.

A description is given, with photographs, of the full range of ultra-violet lamps now available in America. C. A. M.

IV.—LIGHTING EQUIPMENT.

317. Lighting Fittings. Anon.

El. Review, Vol. CXIII, No. 2916, p. 481, October 13th, 1933.

Describes and illustrates a large number of modern lighting fittings, mostly of a decorative character. J. M. W.

318. Methods Used to Select Commercial Lighting Fixtures. Karl Staley.

El. World, 102, pp. 494-496, October 14th, 1933.

In selecting commercial lighting fittings, it is stated, a competitive test, held on the customer's own premises, is desirable. The methods of test, and the conclusions drawn from a comparison of the products of seven companies, are shown in tabular form. W. C. M. W.

319. New Reflector Fixing Attachment. Anon.

El. Times, 84, p. 527, October 19th, 1933.

A description, with photographs, of a new type of vitreous enamel reflector. This unit has a special method of fixing which permits the removal of the whole reflector, together with the lamp, thus making efficient cleaning a simple matter. Other advantages claimed are a lower operating temperature of the flexible to the fitting and an increased light-output. W. R. S.

320. Standard Design for Street-lighting Bracket Fixture. Anon.

El. World, 102, pp. 573-574, October 28th, 1933.

Details are given for standard designs of fixtures of the highway lighting type. The fixtures are designed for use on overhead transmission poles. W. C. M. W.

V.—APPLICATIONS OF LIGHT.

321. How Much Light? T.E.E. Committee.

Elect. Engineering, 52, pp. 716-719, October, 1933.

An answer to the question of how much light should be used in the United States to give the proper level of illumination is given in this article. Based upon assumed values of illumination for various purposes and upon an analysis of population, figures are derived which show the percentage of light used in terms of the desirable value. S. S. B.

322. Economic Comparison of Old and New. A. L. Powell.

El. World, 102, *pp.* 568-569, *October 28th*, 1933.

Gives photographs comparing the old with the new lighting in a New York Bank. The installations are compared on a wattage basis, and also on that of lamp replacement. W. C. M. W.

323. The Economic Illumination of Beaming Machines in the Silk and Artificial Silk Industry. F. Putnoky.

Licht u. Lampe, *Vol.* 22, *p.* 527, *October 12th*, 1933.

The author gives details of the points at which good illumination is essential. He also gives curves showing the improvement effected with different types of fittings. E. S. B-S.

324. The New G.E. Institute. Anon.

Light, 3, *No.* 1, *pp.* 16-17, *Fall*, 1933.

Numerous photographs, with details, are given of modern domestic lighting equipment installed in the new G.E. Institute at Nela Park. C. A. M.

325. A New West End Restaurant. Anon.

El. Review, *Vol. CXIII*, *No.* 2918, *p.* 588, *October 27th*, 1933.

Describes and illustrates the lighting of the Marble Arch "Maison Lyons." Novel lighting fittings, architectural strip-light lamps, and "sunray" discharge-tube lighting are employed in the cafés, and 120 floodlight projectors are used on the exterior of the building. J. M. W.

326. Lighting of the Grand Foyer of the Radio City Music Hall, New York. Anon.

Elect. Engineering, 52, *p.* 719, *October*, 1933.

A short description is given of the special large units incorporating heat-resisting glassware used to light this foyer; a photograph is included. S. S. B.

327. Church Lighting Contrasts. Anon.

El. Times, 84, *p.* 538, *October 26th*, 1933.

Two photographs illustrate a short description of an indirect-lighting system recently installed in a church in Surrey. W. R. S.

328. The Artificial Illumination of Large Sports Grounds. A. Pahl.

Licht u. Lampe, *Vol.* 22, *p.* 552, *October 26th*, 1933.

The author describes the lighting equipment of various football fields, none of which is in Germany. He then goes on to discuss the lighting requirements of football fields in general. In the second section details are given of the lighting of a stadium racing track by means of projectors mounted on four masts. E. S. B-S.

329. Lighting the Wacoona Tunnel. J. F. Morton.

Elect. J. Vol. 30, *No.* 10, *p.* 429, *October*, 1933.

A rock vehicular tunnel, 4,000 ft. in length, is illuminated by 4,000-lumen lamps in deep spherical vitreous-enamel reflectors, mounted 17 ft. 3 ins. above the roadway at 30 ft. spacing. 6,000-lumen lamps, in conjunction with a specially light-coloured floor, were used near the entrance, to prevent too rapid a change in brightness level on entering the tunnel. J. M. W.

330. Floodlighting. Part II. T. E. Ritchie.

G.E.C. Journal, *IV*, *pp.* 215-228, *November*, 1933. *For Part I see Abstract No.* 298, *December*, 1932.

The solutions of various recent floodlighting problems are dealt with in detail, with particular reference to the installation at Buckingham Palace in 1931. C. A. M.

331. Modernization of a Fountain. Anon.

Elect. Engineering, 52, *p.* 721, *October*, 1933.

A brief description and photograph of a fountain at San Diego, California, illuminated by a changing system of colour floodlights. S. S. B.

VI.—MISCELLANEOUS.

332. The Efficiency and Luminous Output of Fluorescent Materials. S. A. Dressler.

Das Licht, *p.* 185, *September 15th*; *p.* 204, *October 15th*, 1933.

The author briefly reviews the principles underlying fluorescence, and gives particulars of filters enabling various bands of radiation to be isolated. Curves illustrating the performances of zinc sulphide, rhodamine, etc., are presented, and a table comparing the chief properties and efficiencies of various substances is given. J. S. D.

333. Photo-cell Control Widens in Industry. Anon.

Electronics, 6, *pp.* 268-272.

An article on the general application of photo-electric devices to industry, followed by a complete list of uses, mostly in actual operation at present. S. S. B.

334. "Stroborama" Cinematographic Stroboscopic Apparatus. Anon.

Rev. d'Optique, *Vol.* 12, *No.* 9, *p.* 368, *September*, 1933.

A stroboscopic arrangement coupled with a cinematographic camera. The object is illuminated by a gaseous discharge tube through which a condenser is discharged, the discharge being ignited by the discharge of a small pilot condenser and transformer, and controlled by a gearing arrangement. J. M. W.

The Illuminating Engineering Society

SPECIAL MEETING IN LIVERPOOL.

We learn that arrangements have been made for a special meeting to be held in Liverpool, under the auspices of the local circle of the Illuminating Engineering Society for the North-west Area, whose Hon. Secretary (Mr. James Sellars, Highways Department, Town Hall, Manchester) will be glad to hear from anyone anxious to join the circle.

The meeting is to be held in the showrooms of the Liverpool Corporation Electricity Department (9-11, Whitechapel), on Wednesday, December 6th, at 7-15 p.m., when a paper on Dock Lighting will be read by Mr. J. S. Preston, M.A.

Previous to the meeting there will be a visit to the Liverpool Docks, for which the party will assemble at the Gladstone Dock station of the Liverpool Overhead Railway at 4 p.m. As the number of the party is limited, those wishing to take part in the visit should communicate with the local Hon. Secretary at the address given above.

PUBLIC LIGHTING.

SIR,—In the course of Mr. G. H. Wilson's extremely interesting paper on "Electric Discharge Lamps and their Application to Public Lighting" there are several points raised which have an important bearing on the general design of street-lighting equipment.

In the past six months there seems to have been a general tendency to regard an even road brightness as the chief desideratum rather than either uniform illumination or alternate light and dark patches which were, until recently, regarded as giving the best visibility. I notice in this connection that Dr. Lux, of Berlin, in a recent paper* to the German Institute of Gas Engineers supports this view on the grounds that:—

(*a*) The system of alternating light and dark patches results in a blind spot at which the brightness of object and background are equal, and

(*b*) Rapid change in adaptation level necessary in this system leads to visual fatigue.

Personally, I feel somewhat sceptical of the former statement, which I believe can only apply to streets in which the spacing is very great, and consequently the light or dark zone is sufficiently big to enclose the figure of a pedestrian.

Granted, however, that even brightness is desirable, it is not obvious from the figures given in Table I of Mr. Wilson's paper that this even brightness has been attained. It is true that a figure of 1.4 to 1 is quoted, but it is also stated later in the paper that these measurements were made along a straight line parallel to the kerb and between it and the centre of the road. It is a matter of common knowledge that when lamps are placed on the side of the road the lowest brightness is normally to be found in the centre of the road, and conversely the central arrangement gives the lowest brightness near the kerb. Consequently the brightness measurements as quoted in this paper only refer to that portion of the roadway which is normally of even brightness, i.e., within the bright streak which always occurs in the road on a direct line between the observer and the lamp. Even the photographs of this particular installation (which are evidently not meant to illustrate a high diversity of brightness) clearly show a darker zone in the centre of the road. Will Mr. Wilson tell us what the real diversity of brightness on this road is?

It also appears from the discussion at Margate that Mr. Wilson regards a high candle-power at angles near the horizontal, which must inevitably cause glare, to be a necessary condition for even brightness. In view of the considerations set forth by Langlands in his paper on "Street Surfaces and Public Lighting"† it would appear that even brightness depends rather upon the width of the specular streak than the length, and furthermore that the width of the streak is controlled almost entirely by the nature of the road surface. It is quite conceivable that a glaring light might lengthen the streak of light caused by specular reflection on a road surface, but in most cases this is quite long enough; the dark patches are usually to be found between the streaks, i.e., the streaks are not sufficiently wide. It may be that in this particular installation the road surface helps by giving a wide streak, but I find it difficult to understand why a high candle-power in such a direction that it can only glare the eyes of the motorist, and cannot affect the illumination of the street to any appreciable extent, can now be complacently accepted by designers of street-lighting plant as a necessary evil.—Yours truly,

L. T. MINCHIN.

SIR,—Mr. Minchin has referred to some of the fundamental considerations in connection with the design of street-lighting installations arising out of my paper to the A.P.L.E.

There is little doubt that at the present time uniformity of road-surface brightness is becoming more generally recognized as an important factor in effective street lighting. There are, in my opinion, two main reasons for this. The first is that the technique of light-control has so developed that now it is possible by means of refractors and reflectors to control road-surface brightness distribution over a wide range. The second is that the increasing use of the roads by fast motor traffic necessitates the provision of a lighting installation in which the road user can be confident of his ability to see.

On the whole, my own observations have indicated that in an installation which produces light and dark patches it is possible for large objects to be invisible in the near dark regions, and a small animal could disappear in a distant dark patch.

As a road user, I should summarize the requirements of a good system of street lighting as follows: "to give such a visibility that the observer feels confident that any object of material size up to at least 100 yards ahead (this is a tentative figure) will be clearly visible, without any discomfort due to glare." Even in an ill-lighted thoroughfare it may be possible after close scrutiny to see all that is necessary, but this would not be good enough for a motorist who requires to see at a glance.

What minimum level of brightness, what maximum diversity and distribution of brightness and what degree of glare are permissible is not yet fully known. I do know, however, that there is a very general opinion that the installation of high-pressure mercury-vapour lamps illustrated in Fig. 19 on p. 25 of my paper at Margate is in all the above ways adequate.

The diversity of brightness in the above installation along the two lanes of light on the near side of the road, 5 ft. out from the kerb, has already been given as 1.4 to 1 over one span. This figure of diversity tells the variation in brightness of the lane down which one is driving. With such a small variation in the lane there appears no dark region in which one feels objects can disappear and the driver has confidence in his ability to see.

* Gas und Wasserfach, 76, (30), 573.

† "Street Surfaces and Public Lighting." S. B. Langlands. Inst. Municipal and County Engineers, June, 1932.

FIG. 1.

FIG. 2.

With side mounting the middle of the road will invariably be darker than the edges.

To my mind, this is better than the state of affairs which occurs with central suspension when the sides (i.e., the regions near potential sources of danger, the kerbs) are darker than the middle. In the installation under consideration, further measurements have now been made, and the maximum diversity of brightness in span 1—2, where the road surface is the same as that shown in Fig. 19 of my paper, has been found to be $5\frac{1}{2}$ to 1. This is between positions A and B in Fig. 1, and such uniformity is somewhat of an achievement. A practical test has given information on the visibility conditions resulting, and Figs. 1 and 2, although only photographs, and therefore capable of being made to produce any results, give, in the opinion of the observers, a very fair idea of the noticeability in the installation. The cats were made of painted wood having reflection factors of 5 per cent. and 15 per cent., and they are both clearly visible, whether in the foreground 40 yards away (Fig. 1) or in the distance 100 yards away (Fig. 2). They always appeared dark against the background, and this would probably apply to the majority of objects, in view of the high brightness of the road surface. At point A, for example, the road is five times as bright as a perfectly reflecting matt white surface would be at the same point.

In the distant view in Fig. 2 the cats have as background the bright lane on the near side of the road, but even when put into the darker middle in such a position that the vertical illumination on them was a maximum (and the contrast with the background therefore a minimum) both grey and black cats were visible, although the grey one had nearly disappeared.

A photograph would have been taken in this position had not a passing motorist appealed to the arm of the law for the removal of cats which would not respond to normal persuasion.

In regard to the methods of producing such an installation I do regard as an essential to the economic production of a high uniform road brightness, a light distribution from the lantern up and down the street in which the intensity at angles near the horizontal is not far below that at 70° or 80° to the downward vertical. Mr. Minchin states that this must inevitably produce glare, but he does not mention magnitudes. In a brightly lighted highway in daylight a 50,000 candle-power headlight causes no distress; in an artificially lighted street the extent of the glare from a unit of given candle-power will depend on the level of surface brightness in the installation, and in the case under discussion it is my firm belief that there is no sensation of glare produced in such magnitude that any reduction in candle-power, and consequently road-brightness, should be contemplated.

The reduction of brightness diversity across a given street surface (which amounts to increasing the "width" of the bright streaks) can only be controlled by the lateral distribution of intensity from the fitting. But, in reply to Mr. Minchin's point, I would say that an endeavour to produce even brightness requires consideration of the intensity distribution from the fitting at all angles. One cannot speak accurately of the light-distribution up and down the road as distinct from that across the road nor of lengths and widths of streaks. Light which is reaching the middle of the road at any angle must affect its brightness and that from distant fittings strikes it at high angles of incidence. For example, point A on the road illustrated receives light from the second post on the right at an angle of 77° and from the third post at 84°. These are angles at which a high candle-power can produce glare if it does not also produce a high road brightness but at which it will also produce an apparent increase in the "width" of streak. I do not think that the brightness diversity down the length of a streak will be as uniform if a bare lamp is used as if the same lamp is employed in a fitting giving a specially designed distribution, nor do I think the diversity across the street would be as low in the first case as in the second.

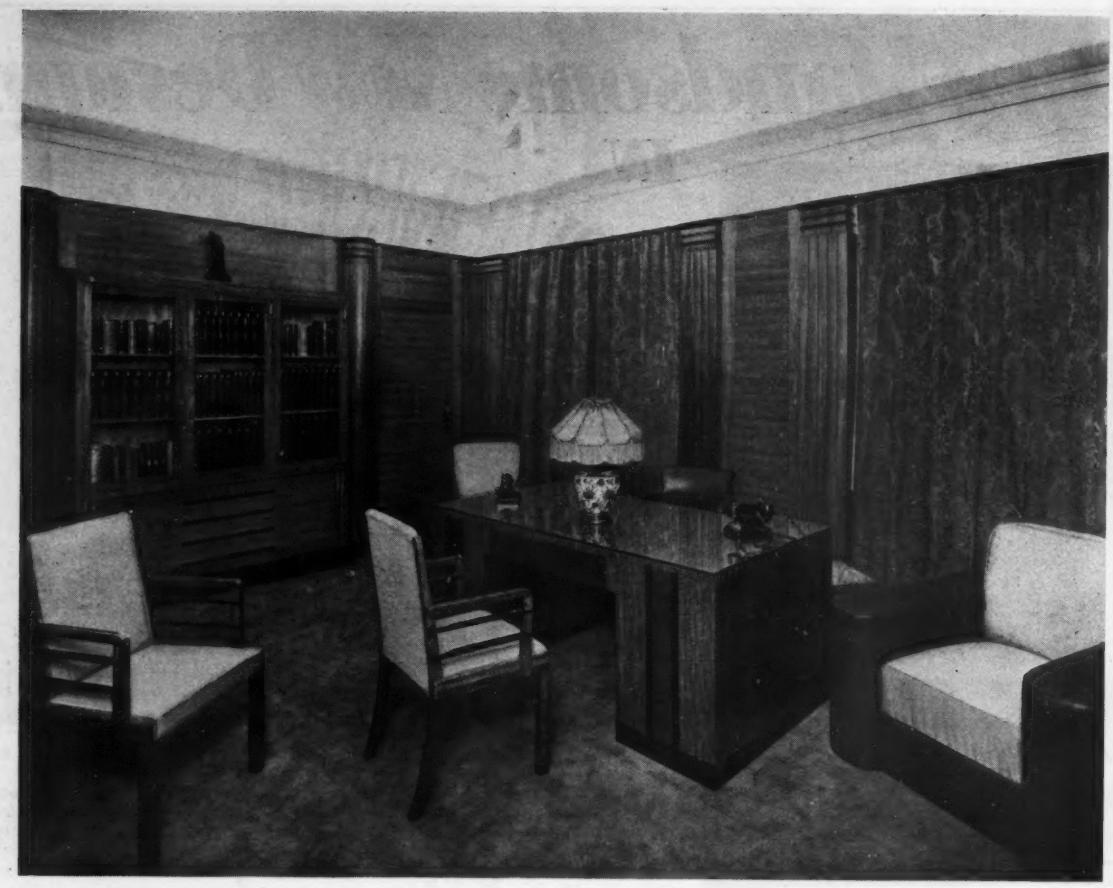
One last point. Naturally, as Mr. Minchin suggests, the road-surface reflection characteristics affect the road-brightness. For instance, it will be evident from Figs. 1 and 2 that tarring and sanding the road beyond the second post on the left has reduced the road-brightness by a considerable amount. It is to be hoped that when rather more polished its useful reflection properties will return. But it must not be thought that the area of surface which appears bright is solely a function of the street-reflection characteristics and is independent of the lateral distribution of candle-power from the fittings. In the installation under discussion the units do not produce "streaks" but "lanes" of light, and the rate of change of brightness across these lanes is a function of the distribution of intensity from the units as well as the road reflection properties.

The satisfaction which this new installation has produced can surely be credited to the use of equipment which provides an adequate amount of light distributed in a manner suited to the reflection characteristics of the road. If this provides "accident-proof" lighting, it is one solution of the problem of highway lighting.

Yours faithfully,
GEO. H. WILSON.

The New Southampton Docks

By the courtesy of the Southern Railway all the members of the Illuminating Engineering Society who took part in the visit on October 24th received an illustrated description of the new Docks Extension at Southampton. We are quite sure that this record of one of the most remarkable coast-undertakings of recent years will prove of great interest to all members of the party.



The above illustration, which was reproduced from an untouched photograph taken with all windows obscured, shows the cornice-lighting by G.V.D. Illuminators of the Managing Director's Office, Odham's Press Ltd. We are informed that the present consumption is 1,200 watts, as compared with 1,580 previously used, and that the illumination has been increased from 4½ to 10 foot-candles. Furthermore, it is stated that only 16 lamps are in use, replacing a previous installation of 112. The photograph is presented by the courtesy of Hampton & Sons Ltd. The architects were Messrs. Yates, Cook & Derbyshire.

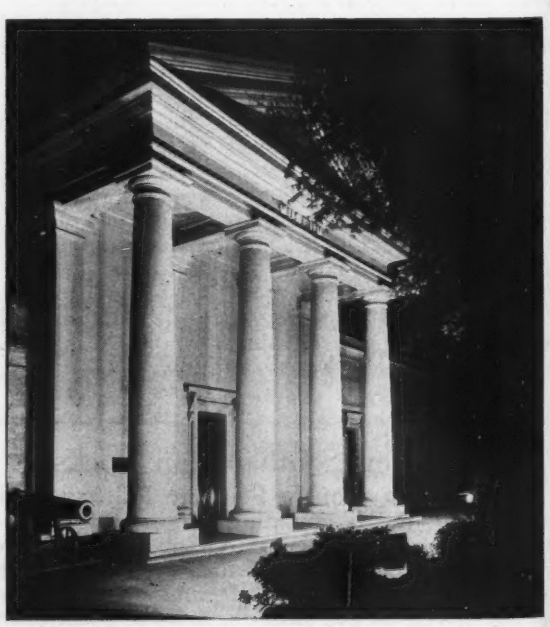
Floodlighting with Electric Discharge Lamps

The possibilities of the new electric discharge lamps for floodlighting are well illustrated in the adjacent illustration, which shows the illumination of the entrance to the new Museum and Mayor's Parlour during the recent meeting of the British Association in Leicester. This installation was carried out with the new Royal Ediswan "Escura" lamps, furnished with Ediswan "Saturn" projectors. The consumption was 3 kilowatts, as compared with the 7 kilowatts that would have been required for the same result with ordinary gasfilled filament lamps.

The "Escura" lamp, which was shown at the opening meeting of the Illuminating Engineering Society on October 10th, furnishes approximately 40 lumens per watt, so that the luminous output of this 400-watt lamp is nearly equal to that of a 1,000-watt gasfilled filament lamp. The lamp is suitable for use on 200-250 volts alternating current. Its general design conforms to that of other gaseous discharge lamps already on the market, with certain modifications introduced as a result of experience during the last few months.

For starting, neon gas filling is used instead of the more usual argon, and this, it is stated, makes up a little of the deficiency in red, which is an inevitable accompaniment of mercury-vapour lighting.

The lamp is made to operate in the vertical position with cap either up or down, and for floodlighting, standard Ediswan lanterns can be used without adaptation. For lighting large areas, such as streets, arterial roads, recreation grounds, docks and sidings, special equipment has been designed. The life of the lamps is stated to be at least 1,000 hours.



The floodlighting of the entrance to the Leicester Museum and Mayor's Parlour with "Escura" Lamps in "Saturn 5" Floodlanterns during the recent meeting of the British Association.

FIG. 1.
A General View of a portion of the newly arranged G.E.C. Showrooms, containing an interesting display of fittings utilizing tubular lamps.

The New G.E.C. Illumination Showrooms

In our last issue we referred briefly to the visit of the press to the reorganized illumination showrooms of the General Electric Co. Ltd., at Magnet House. We now give several views illustrating some of the effects seen on that occasion. These showrooms are of great interest because both the old and new schools of thought are represented. One can seen excellent examples of the familiar chandeliers, bracket lights and table-lamps of the past (the conventional form of table-lamp, to our mind, still holds its own, not only because it affords a most comfortable form of illumination for reading, but also because of its inherent decorative value). One passes from these fittings to the very latest types, as embodied, for example, in geometrical bracket designs and assemblies of tubular lamps. Some of the latter are seen to advantage in Fig. 1.

Even before entering the fittings showrooms, however, the casual visitor must be struck by the evidence of new ideas. He will be struck, for example, by the variety of colours now available from discharge tubes, as exemplified by the lemon-yellow colouring of the tubing on the building facing Magnet House, and the soft pinkish glow of the "sun-lighting" outside the G.E.C.'s own premises—the latter a particularly pleasing hue.

The most interesting section of the showrooms, undoubtedly, is that devoted to architectural lighting. These "built-in" devices are applied to the walls, ceiling and cornices, and may take varied forms, as seen in Figs. 2 and 3. In the background of Fig. 2 will be seen an ingenious built-in lighting fitting simulating an overflowing fountain. A striking feature here is the contrast of colouring present when the fitting is alight and extinguished —the latter effect being itself quite a charming one.

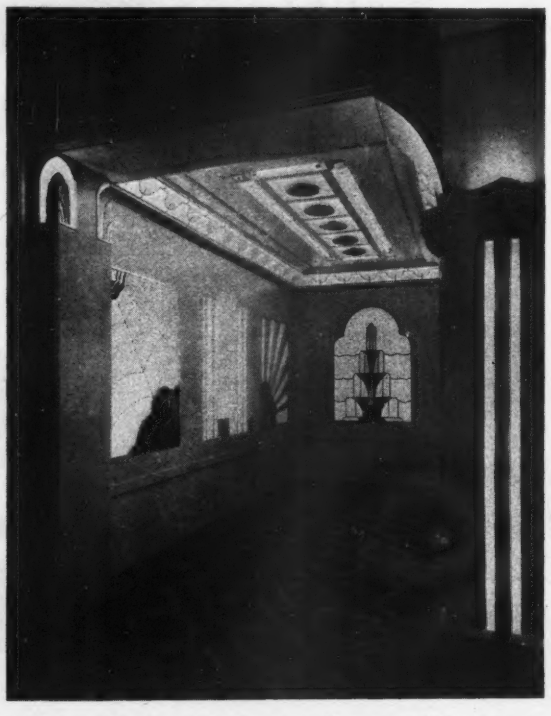


FIG. 2.—A view of a section of the Architectural Lighting Department in which novel concealed lighting effects on the ceiling, the cornice and the walls are illustrated.

On the walls will be seen other curious devices, such as a contrivance occupying the central position on the wall on the left, which deliberately uses a "spotty" effect of lamps behind translucent glass in order to imitate coloured curtains. The ceiling device causes the polished-metal bowls to "float out" from their background. Here again the transformation in appearance when the fitting is lighted up is very striking.

The most useful feature of all, in the writer's opinion, was the cornice, combining a rose-tinted luminous background with delicate silver metalwork in front. In Fig. 3 other curious effects are seen, such as the central "organ-pipe" arrangement (tubes of coloured glass with a luminous background) and a creation built up mainly of inclined mirrors.

FIG. 3.—Another aspect of the Architectural Lighting Section in the G.E.C. Showrooms.

It will be observed that this new mode of lighting eliminates some of the features which figured prominently in the art of the fittings designer of the past. One notes, for example, the absence of elaborate metalwork. The curves—sometimes too tortuous—of metal chandeliers tend to be replaced by relatively simple linear effects. One observes also the subordination of the source—we have no longer a definite lamp and shade entering into the picture. The craftsman need not fear, however, that he will not have ample scope for his ingenuity and taste. The new field, in which the functions of the fittings designer and the decorator are so closely linked, surely offers him greater scope than ever.

Personal

Mr. M. J. Railing, joint managing director of the General Electric Co. Ltd., has been appointed vice-chairman in succession to Mr. E. G. Byng, who has resigned that position for reasons of health. Mr. Byng will still remain on the Board.

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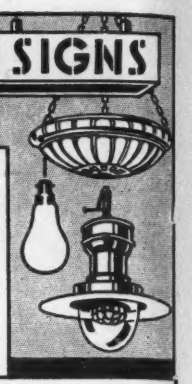

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Sheffield Illumination Society

On November 8th, 1933, members and friends of the Sheffield Illumination Society listened to a very interesting lecture on "Sheffield a Century Ago," by Mr. J. E. Tyler, M.A., of the Sheffield University. Mr. Tyler gave a descriptive picture of Sheffield of that period, and pointed out incidentally that Sheffield was not as black as it was painted in history books. He then went on to give an account of the various activities of the city.

An Important Development in Electric Lamp Manufacture

An announcement of considerable interest in connection with the manufacture of electric lamps is made by Messrs. Philips Lamps Ltd. Hitherto it has been found expedient to burn such lamps cap-upwards. When so burning the filament rests on the closed end of the small eyelet (the hook supporting the filament) and, when current passes, a short-circuit takes place at the point of support. This is, however, a very minor short-circuit that does not materially affect the lamp, but when the lamp is burned in the reverse position (i.e., cap-downwards) the filament rests on the other side of the eyelet and touches this in two positions. The short-circuit thus caused is of moment, as a reduction in length of the filament of 5 per cent., with a resultant over-running of 5 per cent., may reduce the life by no less than 50 per cent.! Even when a lamp is burned horizontally a similar condition operates.

The new invention now announced—which requires machinery that is almost human in action—involves the formation of the eyelets *after* the filament has been laid on its support. It is thus possible to close them completely. The filament now rests inside a completely closed loop, and can only touch in one place at a time in whatever position the lamp is burned.

Recent Visits to Showrooms

During the last month there were opportunities of visiting the showrooms of several of the leading firms in the lighting industry. On November 13th there was a display in the premises of the Edison Swan Electric Co. Ltd., in Charing Cross Road, where a good chance of seeing old and new fittings side by side was afforded, and several interesting novelties (such as the ultra-violet incandescent lamp recently shown to the Illuminating Engineering Society) were on view.

On November 23rd, at Magnet House, members of the Incorporated Institute of British Decorators assembled in large numbers. Here again a chance of seeing over the new illumination showrooms (elsewhere illustrated in this issue) was afforded. Subsequently Mr. E. H. Penwarden and Mr. R. O. Ackerley lectured in a lucid manner on some of the architectural lighting devices which the visitors had been inspecting.

Modern School Lighting

We have received particulars of the lighting of the Leyton Education Committee's new school at Connaught Road, in which Siemens gasfilled lamps and fittings, and also Benjamin "Benflux" fittings, are used. We hope to illustrate this in our next issue. Meantime the contractors (Messrs. Harland & Wolff Ltd., of North Woolwich) deserve congratulations on the job.

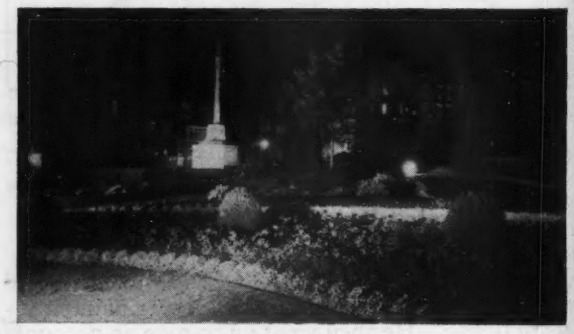
The Kelvin Hall Floodlighted

A view of the famous Kelvin Hall, Glasgow, floodlighted by night. The projectors were carried by the ordinary lighting standards, and the idea was to bring out the salient features of the building rather than to make the entire mass equally brilliant. The luminous band—which in some degree seems to detract from the general effect—was, we understand, a special addition made by the Exhibition authorities.

Floodlighting with Gas

We reproduce below views of the floodlighting by gas arranged by Messrs. W. Sugg & Co. during the period of the tenth annual conference of the Association of Public Lighting Engineers in Margate (September 4th-7th). The illumination of the headquarters was admittedly effective, and the floodlighting of the flower-beds and shrubberies in the War Memorial Gardens recalled the display in St. James's Park during the International Illumination Congress (1931).

Floodlighting of the Headquarters of the Association (the Queen's Highcliffe Hotel).



Floodlighting in the War Memorial Gardens.

Edison Swan Electric Co. Ltd.

REMOVAL OF HEAD OFFICE.

On December 4th, 1933, the Head Office of the Edison Swan Electric Co. Ltd. will be transferred from Queen Victoria Street to 155, Charing Cross Road, where all communications should be addressed. Tel., Gerrard 8660. Business at the Trade Counter, 228, Upper Thames Street, will be carried on as usual.

Printed by Taylor Garnett Evans & Co. Ltd., Manchester and London.